CIVIL ENGINEERING

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A WPA Project Near Atlanta, Ga. In Lessons from Thousands of Such Government-Aided Projects, Writers in This Issue Find the Basis for a Sound and Continuing National Policy in Regard to Relief and Public Works

Volume 9 — Number 2 —

FEBRUARY 1939

Civil Engineers' Salaries—See Page 111

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AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

FEBRUARY 1939

Civil Engineers' Salaries—See Page 111

TAXES-PEOPLE & PIPE

"Son, that pipe is going to save you money"
"TAKE a good look, son. That's cast iron pipe and it won't have to be dug up and replaced for a century. Downtown there are cast iron water mains older than I am. Suppose the city had to replace them? All of us property owners would have to share the cost. I'm saving those extra tax dollars because cast iron pipe serves for a century. When you grow up to be a taxpayer, it will save you money, too."
* * *
Water mains represent about one-third of this country's 5-billion-dollar investment in public water supply systems. More than 98% of these mains are cast iron pipe with a known useful life at least double the estimated life of other water main materials. Because the tax-saving, through deferred replacements alone, is enormous, cast iron pipe is known as Public Tax Saver No. 1. It is the only ferrous metal pipe, practicable for water, gas and sewer mains, which rust does not destroy. Made in diameters from 1¼ to 84 inches.
Unretouched photo of cast iron water
installed in St. Louis more than 100
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* * *

It is to the advantage of water works officials that the public shall realize that water mains represent about one-third of this country's 5-billion-dollar investment in public water supply systems—that more than 98% of these mains are cast iron pipe with a *known* useful life at least double the *estimated* life of other water main materials—that the consequent tax-saving, through deferred replacements alone, is enormous—and that cast iron pipe deserves to be advertised as Public Tax Saver No. 1.

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ENGINEER, 1015 PEOPLES GAS BUILDING, CHICAGO

CAST IRON PIPE
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Among Our Writers

V. T. BOUGHTON gained first-hand information on labor questions as a trainmaster on the Canadian Pacific following the War, and later as a gang foreman on construction. Since returning to New York he has served almost continuously on committees of the Metropolitan Section having to do with professional matters and problems of engineering employees.

CHARLES E. DEL EUW (University of Illinois, 1912 and 1916) has been consulting engineer for the Department of Subways and Traction, Chicago, since 1936, but his experience with Chicago's traction problems extends back to 1922. His present assignment includes investigations and plans for all local transit development and modernization.

ROBERT L. MACDOUGALL (Georgia School of Technology, 1925) was for seven years president and general manager of Wilson MacDougall Lumber Company. Since 1933 he has been in charge of work programs, in Georgia, of various agencies operating under FERA, CWA, and WPA.

STANLEY H. WRIGHT has had 37 years of engineering experience, specializing in water supply and purification and hydroelectric work. Since 1920, except for a period as city engineer of Asheville, N. C., most of his work has been in private practice in Pennsylvania and North Carolina.

FREDERICK H. MCDONALD served during the War as first lieutenant with the 105th Engineers. In 1924 he became head of McDonald and Company, engineers and architects, and in 1932 he began his consulting practice, dealing largely in the field of engineering economics and finance. He was instrumental in organizing the Engineering Economics Division and is now its chairman.

E. W. LANE has been connected with a number of flood-control projects including those for the Miami River, the Arkansas River at Pueblo, Colo., the Mississippi River, and the Huai and Yangtze rivers in China. He has also been engaged on studies for numerous American waterways.

E. J. CHRISTENSON has been employed by the U. S. Engineer Office in St. Paul since his graduation from the University of Minnesota in 1927. He has acted as assistant resident engineer on three of the Mississippi River locks and dams.

ARTHUR L. ELLIOTT (University of Washington, 1933) after several years with the Bureau of Public Roads, was on the San Francisco-Oakland Bay Bridge from the time when the first caissons were being sunk until the bridge was opened to traffic. He is now with the California Bridge Department.

C. N. JOYNER, an American by birth, is in the employ of the British and is a director of the Association of Chinese and American Engineers. He is an amateur telescope-maker and astronomer, and the author of a monograph on the moon, recently published in the United States.

CHARLES U. POWELL (Cornell, 1898) became an engineer for the Rapid Transit Subways, New York City, in 1900. Since 1915 he has been engineer in charge of Queens Topographical Bureau, City of New York, engaged in city planning for the entire borough of 75,000 acres.

HERBERT L. WHITE (University of Illinois, 1926) has been on the physical plant department staff of that university for seven years, and is now in charge of the university water supply and iron-removal plant and of the operation of purification equipment for three indoor swimming pools.

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineering Societies and Unions

Address Before Washington Convention of F.A.E.C.T. Abstracted

By V. T. Boughton

Associate Member American Society of Civil Engineers
Managing Editor, Engineering News-Record, New York, N.Y.

THE relation of architectural and engineering societies to unions of technical employees in their fields was made the subject of open discussion at a mass meeting held in Washington, D.C., on Dec. 9, 1938, in connection with the fourth annual meeting of the Federation of Architects, Engineers, Chemists, and Technicians (C.I.O.). At that meeting, V. T. Boughton, chairman of the Society's Committee on Unionization, was asked to speak for the engineering societies. L. K. Justement, president of the Washington Chapter, American Institute of Architects, spoke for the architects. Mr. Boughton's comment, in slightly condensed form, is given herewith. The subject is one of major importance to the profession at this time.

I DID not came here to make a formal speech as an official representative of any engineering society; I came simply as one interested in this question to participate in your discussions of the relation of unions to the professional groups, in the hope that I might help to eliminate some of the misunderstandings and misconceptions that now exist. There are those in the professional groups who see no good in the unions, and there are those in the unions who see no good in the professional groups. Neither of these extreme views is right. What we need most at the present time is tolerance on both sides, a willingness to see the other man's problems from his viewpoint.

Engineers' Ideal Developed.—One chief source of misunderstanding on the part of engineers is the aggressive technique by which a trade union builds up and maintains its membership. Engineers do not like to be railroaded or regimented. But there is a more important reason for their dislike of unions. That is because the union movement goes contrary to their long struggle to build engineering into a strong profession. Their ideal is the engineer who in accepting a fee for his services is not taking so much cash for a measurable amount of work but is engaging to become his client's agent for the time being, concerned as much with the client's interests as is the client himself, but better able to handle them because of his training.

Many years were spent in developing a code of ethics which would keep the business activities of the individual practitioner on such a high plane. In the early days of that effort employee problems were practically nonexistant because even in the large organizations, like the railroad engineering offices, conditions were not unlike those in the typical consulting engineer's office, where the "old man" knew everybody and probably everybody's wife and children. Pay was not high, but in dull times the "old man" managed to carry most everybody along; and then when he did land a job everybody pitched in, working to all hours of the night if necessary to make it a success. Most of the employees looked forward to the day when they would have their name on the door or would have offices of their own. These men neither sought nor needed the aid of a trade union.

Today, though the great majority of our engineers are employees in large organizations of one kind or another, the traditional conception of engineering persists—and it is a good thing that it does because we lose something which no corporation with all its efficiency can replace when we build an organization so big that the personal relationship is lost.

So much for background. What is the present situation in the engineering societies with regard to unions?

Committee Studies Are Enlightening.—I can't speak for the mechanical and electrical societies because I know

little of what is going on within those organizations, but in the American Society of Civil Engineers I know that there is a surprisingly rapid recognition of the fact that the question as to whether or not a man should join a union is an economic one which is of little if any concern to that Society. About two years ago the Society set up a committee to study unionization. Last January it made its first report; doubtless many of you have seen it. The committee's findings may be summarized as follows:

(1) Whether or not a man joins a union is an economic question for him to decide. It should have no bearing on his standing in the Society. (2) The Society should not participate in any move to exempt engineers from the provisions of the Wagner Labor Relations Act. It should if necessary participate in efforts to clarify the position of professional men and subprofessional men under the Act. (3) The Society should be ready to join with other professional groups in setting up an agency or agencies to aid engineers in collective bargaining if that becomes necessary. And finally, (4) the Society should complete and publish the schedules of grades and minimum compensation on which it has been working for some years. After the schedule is published the Society should be prepared to charge a member with unethical conduct who pays less than the rates prescribed for his region.

Hysteria on Both Sides.—The Board of Direction of the Society accepted the report on unionization and ordered it published. There has been almost no objection to it. Ten years ago I doubt whether such a report would ever have gotten beyond the confidential records of the Board. That in a measure marks how far the Society has gone toward eliminating the hysteria which has surrounded the union question heretofore.

Some hysteria still exists. I am told that unionism and professionalism are incompatible; that an engineer cannot belong to a union and still maintain a professional approach to his work. Well, I am quite frank to admit that I believe that belonging to a union makes it more difficult for a man to maintain a professional approach to his work, but it can be done.

But of course the question of belonging to a union and still maintaining a professional approach to one's work is not an abstract one, as many engineers suppose. It is a very real one for some engineers; and those engineers who find it to their economic advantage to join a union should have no obstacle placed in their way. This fact is slowly being recognized.

The hysteria is not all on the side of the staid old engineering societies. There is a lot on the union side too. Some of your own men have gone farther in the way of absurd statements than have any of the old conservatives in the professional societies. There can be no proper relations between the professional societies and the unions as long as the unions take the attitude that the chief objective of the engineering societies is to hamstring the unions and exploit their members. The professional societies are made up of conservative men who do things in a slow, quiet, and conservative way. To hold their members up to ridicule as interested only in the almighty dollar and unconcerned with the plight of the under dog is both unfair and untrue. These members have done much more for the profession generally than most of you realize.

An Enviable Record.—For example, where did the Professional Engineers Committee on Unemployment originate, in a union headquarters? No, in the board room of the American Society of Civil Engineers. And any engineer, regardless of whether or not he belonged to the Founder Societies, got such aid as the committee could give. Who were among the first to urge upon Secretary Ickes the need for paying engineers on relief higher wages than the laborers' rates first passed out to them? Officers of the American Society of Civil Engineers. From what organizations did the men come who went quietly but persistently to the heads of relief agencies in New York City to plead for better pay and better classifications for engineers in the early days of the CWA and PWA? From the American Society of Civil Engineers and the New York State Society of Professional Engineers. These organizations did not stage sit-down strikes or carry placards, but their representatives generally got what they went after in their own quiet way.

And you should not forget that the Founder Societies are essentially technical societies set up not for the economic advancement of their members but for the assembly and dissemination of engineering information. Welfare questions are new to them. Some members still maintain that these societies have no business getting mixed up in such matters as pay and working conditions.

Relation to Other Efforts.—Regardless of this fact, you may find it of interest to note that the American Society of Civil Engineers has approached these newer questions of employee relations in a more realistic and practical manner than the younger professional societies. The only exception to that statement is a historical one which relates to the American Association of Engineers. If you turn the clock back about twenty years you will find that the A.A.E. centered its interest chiefly in bettering the position of the employee engineer. In those days it did a notable piece of collective bargaining for the engineers in railroad service.

The basic purpose of the American Association of Engineers, the National Society of Professional Engineers, and such organizations as the Bar Association and the American Medical Association is similar to that of unions—that of advancing the economic position of their membership through collective action. But they differ radically in methods and in the fact that they include in their membership both employers and employees.

Value of High Union Standards.—For my own part I do not see any strong reason why many licensed professional engineers will find it necessary to join a union, because most of them are fairly well able to look after their own needs either as individuals or through the state professional societies; but this is not true of the very large number of men who can be most conveniently classed as subprofessional. So long as the state professional societies treat them as step-children, unions such as yours can be of help to them in many instances. Your problem, then, is to build a union of such high standards that they will join not in self-defense but because they want to do so. If you succeed in building such a union the antipathy of professional men to unions will largely disappear. It is a real challenge if you seek to reach the professionally minded engineer.

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NUMBER 2

Rapid Transit Subways for Chicago

Initial Routes Comprise 7½ Miles of Double-Track Line; Only 18 Months Allotted for Construction

FROM AN ADDRESS AT A JOINT MEETING OF THE ILLINOIS SECTION AND THE WESTERN SOCIETY OF ENGINEERS

By CHARLES E. DeLEUW
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHARLES DeLEUW AND COMPANY, ENGINEERS, CHICAGO, ILL.

SOME time in 1940, under present plans, Chicago's first passenger subways will go into operation. Two routes, both traversing the Loop district, are included in this $40,000,000 project now being built under a grant agreement between the city and the Federal Emergency Administration of Public Works. In the accompanying article, Mr. DeLeuw gives a general description of the project and discusses in some detail the structural design, existing physical conditions, capacity of the lines, and nature and effects of possible future additions.

AFTER thirty years of investigations, reports, and studies, construction on Chicago's initial system of transportation subways was finally begun on December 17, 1938. To conform with the requirements of the PWA grant, 7½ miles of lines included in the project must be substantially completed by June 30, 1940—only a few days more than 18 months from the beginning of work.

The pattern of the initial development is shown in Fig. 1. It conforms in general to the more important plans which have been advanced for transportation subways since 1916. The routes are planned for rapid transit operation and are designed largely as terminal subways which are calculated to relieve the present congestion on the elevated Loop structure.

State Street Subway (designated Route 1), is to be a two-track line extending from a connection with the four-track North Side elevated railroad north of North Avenue to a connection with the three-track South Side elevated railroad near 14th Street. The total length of the route is 4.22 miles, and the total estimated cost is $21,750,000. Dearborn Street Subway (Route 2) is also to be a two-track structure. It will extend from a connection with the elevated railroad near Milwaukee Avenue and Paulina Street to a stub terminal on Congress Street, just south of Van Buren. The total length of Route 2 is 3.34 miles, and the estimated cost is $18,250,000.

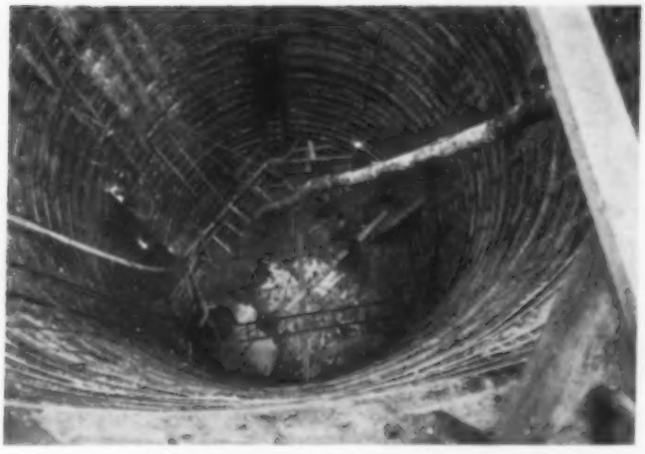
Except for short sections near the terminals, the entire project is planned as a low-level subway to be constructed in tunnel throughout. A reinforced concrete twin tube section (Fig. 2) will be utilized between stations on most of Route 1. On Route 2 and at special locations on Route 1 the tunnels will be separated with track centers at 28 ft.

At each station, platforms 500 ft in length will be provided. At side-platform stations north of the river, these structures will consist of multiple arches—largely of reinforced concrete construction (see Fig. 3, right). The dimensions and type of center arches for the tracks will conform to the sections between stations. However, the side wall will be omitted and the two center arches sprung from a steel girder supported by heavy steel columns on 15-ft centers longitudinally.

Stations with island platforms 22 ft in width are contemplated in the Loop district proper. As shown in Fig. 3, left, the tentative plan provides a multiple three-arch section—two large bores on each side accommodating the trains and a portion of the platforms, with a smaller center arch sprung from longitudinal steel girders supported by heavy steel columns.

In general, stations will be of the mezzanine type, constructed by cut-and-cover methods, and located as close as possible to the street surface. The stations have not been finally designed but preliminary studies indicate that a cover of at least 7 ft 6 in. below the curb grade will be required to accommodate existing and future underground utility structures. The station mezzanine will have inside dimensions of 7 ft 6 in. in height and approximately 60 ft in width and 80 ft in length, the long dimen-

DECEMBER 17, 1938, SAW THE BEGINNING OF CONSTRUCTION ON THE CHICAGO SUBWAY



THE CONTRACTOR'S SHAFT, NEAR CHICAGO AND STATE STREETS, AS IT APPEARED ON DECEMBER 26, 1938

sion being transverse to the center line of the subway. Each mezzanine will be provided with at least four entrance stairways, located generally at the curb.

All mezzanine levels will be connected with low-level platforms by both escalators and stairways. Escalators will have a rise of about 20 ft and will be reversible. Preliminary plans call for separating the entrances to escalators from the entrances to stairways both at the mezzanine level and at the platform, in order to minimize conflict between incoming and outgoing passengers. Escalators and stairways as well as a part of the ventilating equipment will be located outside of the tunnel section, and these, together with the mezzanine station proper, will be let in separate contracts—all to be constructed by cut-and-cover methods.

PROVISIONS FOR VENTILATION, DRAINAGE, AND SO FORTH

The type of section adopted, where trains will operate through separate single-track tunnels, provides a piston-like action and greatly simplifies the problem of ventilation. Openings in the tunnel section—connecting to shafts and to gratings in the sidewalk—will be made on the inbound tracks just in advance of the end of station platforms. These vents will relieve the air pressure caused by the movement of trains at high speeds and will effect a measure of positive circulation. At stations, this natural ventilation will be augmented by exhaust fans connected to ducts located under the platform and to louvers in the mezzanine level, providing for a change of air 6 times an hour. This system of normal ventilation will be supplemented by emergency ventilation units consisting of large exhaust fans located midway between stations—to be operated only in case of fire—with sufficient capacity to clear the entire subway section of smoke in 5 minutes.

About 12 cable-ducts are required for each track for power distribution, signals, lighting, and communication lines. Space for these ducts is provided in banks located on one side of each single-track tunnel, and splicing chambers for cables are placed at intervals of about 400 ft between stations. These chambers involve special openings in the side of the tunnel approximately 4 ft by 10 ft, and will be connected to the sidewalk by manholes. Walks will be provided at one side of each track along the top of the duct bank for emergency use of passengers in the event of tie-ups.

Interior drainage of the subways has been planned in detail. All water entering the subway from any source whatever must be pumped to the city sewer system above the tubes. Wastes from toilets in mezzanine stations will be handled separately at each station by small duplex ejectors, using either "non-clog" centrifugals or compressed-air ejectors. All other drainage will be conveyed through a track drainage system to sumps extending below the track level, and will be pumped from there to the sewer in the street above. The sumps will be located at low points in the subway profile, which are, in general, midway between subway stations. Pump rooms at these points will be combined with emergency fan chambers, electrical switching rooms, and emergency exits.

Designs of all architectural features are in process and pains will be taken to provide attractive, light, and well-ventilated stations. A type of finish is planned which, in addition to being attractive, will stand wear and tear

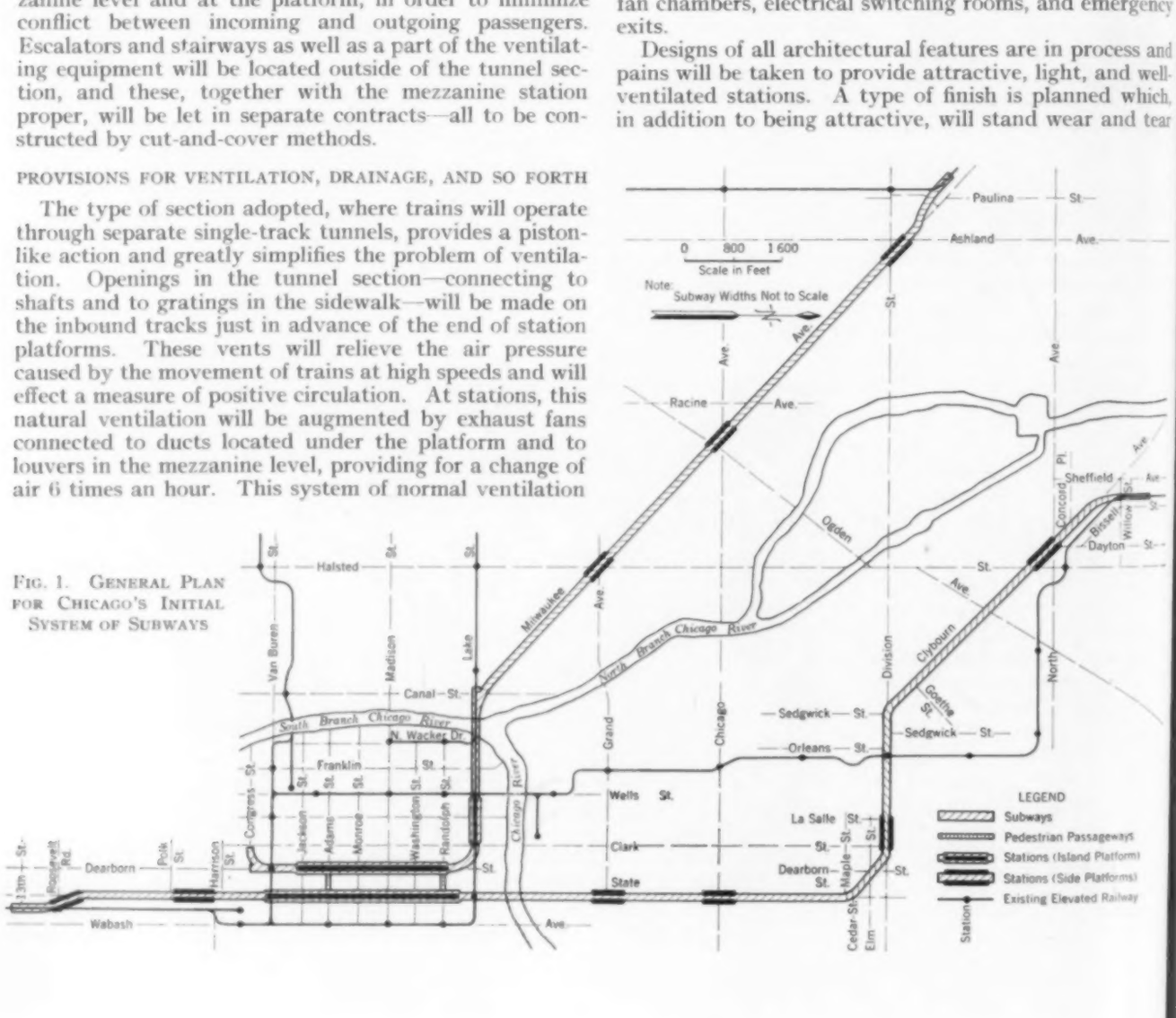


FIG. 1. GENERAL PLAN FOR CHICAGO'S INITIAL SYSTEM OF SUBWAYS

as well as the rigorous atmospheric conditions of downtown Chicago. Tentative plans for illumination provide for a much greater intensity of lighting than has been utilized even in the more modern subways in eastern cities. The intensity will average $2\frac{1}{2}$ foot-candles on the platforms and 4 foot-candles in the station mezzanines and stairways. Lighting may be both direct and indirect, and it is planned to arrange the outlets in such a way that advantage can be taken of the new fluorescent type of lighting if it is found practical.

Eighteen test pits have been dug to obtain information on subsurface conditions. During excavation of the pits, jar samples were taken at intervals of 2 ft; these have been preserved and are available for inspection by contractors or others. In addition, undisturbed samples were taken at approximately 6-ft intervals for laboratory tests.

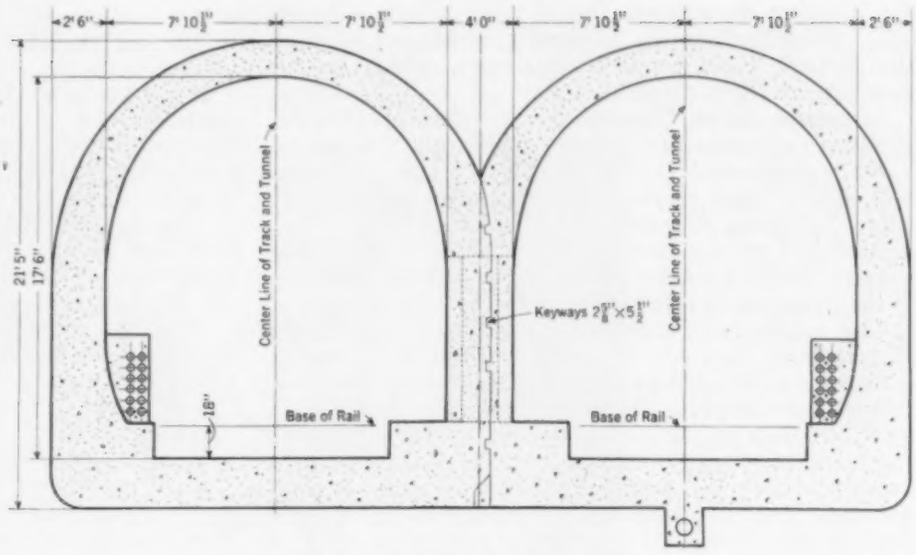


FIG. 2. TYPICAL SECTION OF SUBWAY BETWEEN STATIONS

Data obtained from the pits indicate that the soil underlying the district through which the tunnels are to be constructed is more uniform than that in most cities; in the entire route glacial drift overlies the rock. In the Loop area, the virgin soil is from 5 to 10 ft below the present street grades. The top layer is a fine, yellow sandy loam and silt, changing to gray in color for the lower 2 or 3 ft. This material is water bearing, inclined to run when not sheeted, and subject to considerable shrinkage when the water is drained from it. Below this is a layer of tough to hard yellow clay streaked with blue, and generally merging into a soft blue clay within a depth of 3 to 6 ft. Beneath this, in turn, is a bed of soft blue clay, 30 ft or more in thickness. This clay is dense and contains a large percentage of moisture, although it is almost impervious to the passage of water. It is plastic, sticky, and flows or "swells" readily where not confined. This characteristic Chicago soft blue clay again merges at its lower limits into a tough clay, similar in composition to the soft clay but more dense, because of its lower moisture content. Usually it becomes tougher gradually as the depth increases, often becoming so tough that it can scarcely be cut with a shovel.

Moisture content of clays in the area, on a wet-weight basis, varies from a low of 9.5 per cent in the Loop district to 28.0 per cent on South State Street. In the latter area a large amount of free water was also encountered, due to layers and pockets of sand. On the other hand, the pits along Milwaukee Avenue have been very dry and it was necessary to use "digging" water during excavation.

FACTORS IN DESIGN; LOADINGS AND STRESSES

A factor considered in determining the design specifications was that on the greater part of the work there are imposed, on both sides or on one side only, very heavy loadings due to old buildings supported on so-called floating foundations. In most instances the basements are only one story below the street, which brings the foundations in perhaps the worst possible location so far as superimposed loading of the tunnel structure is concerned.

It must also be borne in mind that many of these old buildings may be removed in the future and replaced by larger and more modern structures. This may place basement areas at greater depths. Therefore the design of any structure built in the street must take into consideration the possibility that soil will be removed within the building lines, thus relieving pressure on one side of the tunnel.

So far as they apply, the design requirements of the Building Ordinance of the City of Chicago have been used. Structural members have been proportioned for that combination of dead and live loads requiring the maximum sections. The dead loads in the subway design include the weight of superimposed earth and roadway, and such building loads as may exist.

The roadway live loads were represented by a train of 24-ton trucks spaced 30 ft center to center longitudinally on each 10-ft traffic lane on the roadway. The distance between axles was taken at 12 ft and the distance between wheels on each axle at 6 ft. The load was assumed to be evenly distributed between the two axles.

The loading on street-car tracks was assumed to consist of two or more 50-ton double-truck cars 49 ft long, coupled together. If the combined dead and live load stresses due to roadway live loads are greater than the stresses due to surface-car loading, the roadway live loads are used. Whenever a load of 300 lb per sq ft of roadway causes greater stresses than the live loads just given, this uniform load governs. Rapid-transit train loads are assumed to consist of a train of 70-ton double-truck cars.

Lateral earth pressures are computed or proportioned in accordance with Rankine's formula, assuming an angle of repose of $1\frac{1}{2}$ horizontal to 1 vertical for dry earth with a unit weight of 100 lb per cu ft. Where the structure extends below Chicago datum into fully saturated ground, that part below datum is designed for a lateral pressure of water at the given depth below datum combined with the lateral pressure of the earth at an angle of repose of $2\frac{1}{2}$ horizontal to 1 vertical, with the saturated portion of the material estimated to weigh 70 lb per cu ft.

The tunnel is designed as a rigid structure so as to resist any combination of loads which may be developed either initially or in future years. With respect to stability, attention is called to the fact that the weight of the completed structure will be somewhat less than the weight of the natural soil it replaces, which is insurance against settlement. It should be noted that the invert of the new subways will be at substantially the same grade as

the invert of the Chicago freight tunnels built 35 years ago. There has been no substantial settlement of these thin-shelled, plain concrete structures, which are in generally excellent condition today.

In general, the unit stresses used are those given in the Building Ordinance of the City of Chicago. The use of 3,000-lb concrete is contemplated, and the allowable unit stresses conform to the American Concrete Institute's "Building Regulations for Reinforced Concrete" as modified by the Chicago Building Code. Allowable stresses used in steel design conform to the specifications of the American Institute of Steel Construction.

The requirement that the project be substantially completed by June 30, 1940, or in a period of 18 months, involves a high-speed program not only in the preparation of plans and specifications by the city's engineering staff but also in the careful planning and high-speed execution of work on the part of the contractor. In order to assure the completion of the project on time, the work is subdivided into 11 contract sections, with an average length of 3,220 ft. Each contract will provide for the construction of all the work to be done in tunnel, including the wider sections at station platforms.

HIGH-SPEED CONSTRUCTION PROGRAM NECESSARY

Work on the first of the tunnel sections was started on December 17, 1938, and work on the eleventh tunnel section will be started in July 1939. Successive sections will be advertised at intervals of about three weeks. The time allowed for completion of each will be from seven to nine months. There will be three special sections covering the cut-and-cover and open-cut work at the three subway terminals. There will be another separate section for two pedestrian passageways in the Loop between Dearborn Street and State Street connecting Route 1 and Route 2.

Plans and specifications for mezzanine stations and all other work requiring open-cut and cut-and-cover construction will be developed during the construction of the tunnels, so as to take bids on the first group of mezzanine stations in August of 1939. It is tentatively planned to award five contracts to cover this construction, and the time allowed for completion is approximately seven months for each. Work on each of the tunnel sections will be practically complete before the contract is awarded for the mezzanine stations in the same sections.

It is contemplated that tunneling will be carried on by methods successfully developed by a number of contractors in the construction of large intercepting sewers built during the last few years by the Chicago Sanitary District. The soil conditions throughout most of the project are well adapted to tunneling methods. The use of 3 lb of compressed air is specified, and it is contemplated that the conditions will be such as to warrant the use of 7 or 8 lb of pressure. No construction procedure is prescribed in the specifications, but the contractors are required to submit their proposed procedure for approval before construction is begun.

The type and section of liner plates and ribs will be selected by the contractor with the approval of the engineer. Grouting behind each row of liner plates will be required in order to reduce the movement of adjacent soil to a minimum. In the first contract on North State Street the contractor is required to provide private property for the construction plant and shaft. This policy will be followed throughout the project where practicable.

The river crossing for the State Street subway will be made by the same method used in constructing the LaSalle Street tunnel more than 25 years ago. Steel tubes will be fabricated on shore, floated and towed to the site, then sunk in a dredged trench. Closure of the water sections with the land sections will be made by cofferdams on each side of the channel. The work under the abutments of the proposed new State Street Bridge will be done in cooperation with the Department of Public Works. Present bridge plans call for the construction of large girders spanning the twin tunnel sections and resting on caissons at each side of the tunnel.

The mezzanine stations, stairways, entrances, and connections will be constructed by cut-and-cover methods. This construction, involving openings 18 to 20 ft in depth and generally about 60 by 80 ft in area, will be done by the methods used on similar work in New York. Pavement and top soil will first be stripped, temporary wooden decking laid on steel cross-beams and girders, and the work of excavation carried on underneath the temporary decking. Existing underground utilities, except

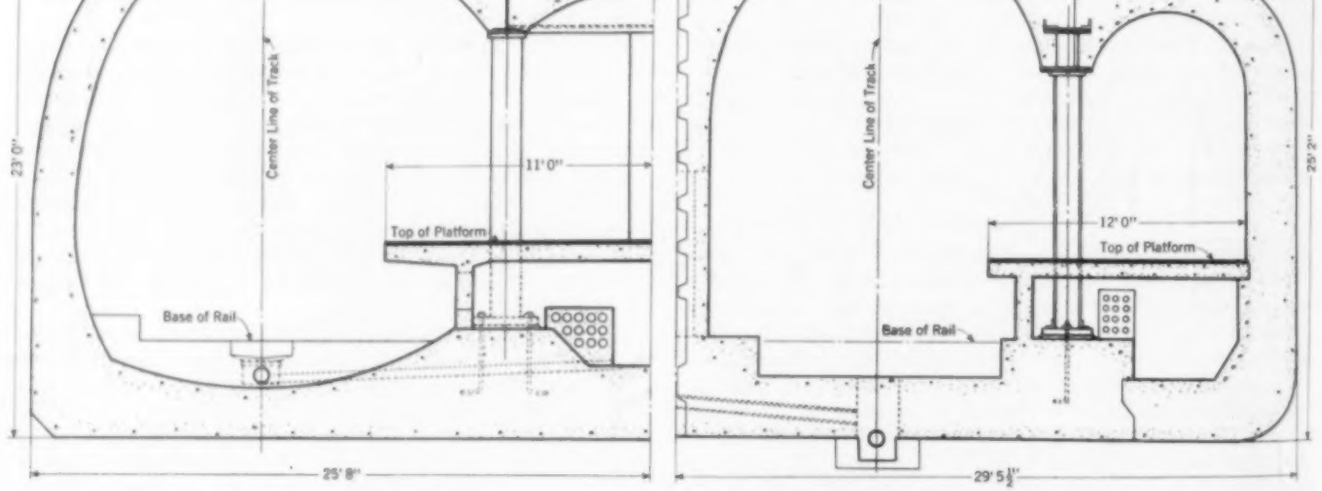


FIG. 3. HALF SECTIONS OF TYPICAL STATIONS: LEFT, ISLAND PLATFORM TYPE; RIGHT, SIDE PLATFORM TYPE

for gas mains, will be supported during construction by steel cross-beams supporting the decking. Temporary sewers will be required, although in some cases sewers can be permanently relocated in advance of station construction.

Station structures proper will be either steel and concrete or reinforced concrete, and in general will be supported on the tunnels previously built. When the stations are completed, the work will be back-filled, utilities restored to their permanent location, and new pavement constructed over the cut.

THE "DEDICATION" PARADE THROUGH THE LOOP—DECEMBER 17, 1938
In the Middle Background Is Part of the Elevated Loop Structure That May Ultimately Be Removed

The existing freight tunnels now owned by the city and operated by the Chicago Tunnel Company will be eliminated on certain of the streets in the downtown district. It should be understood, however, that the subway project will not cause operation of the freight tunnels to be suspended. This comprehensive network of underground freight tubes covers almost every street in the downtown district and therefore has great flexibility. The Tunnel Company may plan the restoration of cross connections along a number of the more important Loop streets. Such new connections would be constructed with an approach gradient of about 3 per cent at each end, and would pass under the Dearborn and State Street subways.

As has been stated, the initial subways are planned for rapid-transit train operation. Before the policy of constructing two-track subways was finally adopted, thoroughgoing analyses were made of present and probable future loads. One of the most important factors considered was the trend in business activities and the number of passengers traveling to and from the central business district. Cordon counts made on a typical week day in various years, covering the period 1926 to 1938, inclusive—of traffic to and from the district bounded by the Chicago River on the north and west, and by Roosevelt Road on the south—show a reduction in total passengers carried to this district by street car, bus, and rapid transit. However the total number of passengers reaching this area by all means of transportation, including private automobiles and taxicabs, has been more or less constant. While the central business district of Chicago is and will continue to be the most important focal area in the city, the activities formerly confined to this district are spreading beyond the river to the north and west. In addition, there has been a definite tendency toward decentralization during the last ten or fifteen years, and many of the activities formerly centering in the Loop are now found in thriving urban and suburban subcenters.

PASSENGER CAPACITY OF SUBWAY

The maximum capacity of two-track rapid-transit subways is calculated by assuming the operation of 40 trains of 8 cars each per hour. Cars with maximum dimensions of 9 ft 6 in. in width and 60 ft in length are contemplated. With an average loading of 100 passengers per car, such an operation will develop a capacity of 32,000 passengers per hour per track. On completion of rapid-transit subway Routes 1 and 2 (with connections to the Lake Street and Garfield Park elevated structures) and with the use of existing rapid-transit tracks on the Wells Street and Van Buren Street legs of the union Loop, there will be three double-track rapid-transit railroads serving the central business district with a total capacity of 192,000 passengers per hour, or 96,000 passengers in the maximum half hour. This total capacity may be compared with the present total combined load for rapid transit, street cars, and motor buses of less than 90,000 in the maximum 30-minute period. Considering the fact that convenience requires the retention of some local bus and trolley-car routes at street grade, it is apparent that this terminal subway layout will provide adequately not only for present but for future traffic for years to come; and that the city is warranted in constructing two-track subways, especially if a large number of north-and-south and east-and-west streets are left open for future subways—when, as, and if required.

The 3,300-ft-long platforms planned for the State Street subway in the Loop district provide space for three double stops—each 1,100 ft in length. Separate berths will be provided at each station stop for trains with different destinations, segregated into two groups, thus providing the broadest possible distribution of incoming and outgoing passengers along the platform and through escalators, turnstiles, and stairways.

Dearborn Street subway, Route 2, will relieve a long-felt need for more direct transportation between the northwest side and the central business district. However, the stub terminal operation which will be required temporarily at the south terminal will not permit the development of the full utility of this unit. Clearly indicated additions consist of a subway connection from Lake Street and Milwaukee Avenue to the Lake Street elevated structure just west of Halsted Street and the construction of a subway connection along the line of Congress Street extended from the temporary south terminal south of Van Buren to a connection with the four-track Metropolitan elevated main line near Halsted.

Upon the completion of the West Side rapid-transit subway as thus indicated, the only service operated over the union Loop would be North Side–South Side trains not operated through the State Street subway (elevated tracks on Wells and Van Buren streets only). The ultimate construction of an additional two-track subway extending north and south along the westerly side of the central district would permit the final removal of the whole elevated Loop structure.

Public Works and Unemployment Relief as Permanent Public Functions

IT is the duty of the engineer, says Frederick H. McDonald, to place his experienced judgment at the disposal of the nation in determining the most effective use of its resources in both materials and labor. With this as the keynote, the Engineering Economics Division presented at the 1939 Annual Meeting a symposium dealing with lessons gleaned from experience in emergency unemployment relief and emergency public works.

R. L. MacDougall, the first speaker, discussed the accomplishments and problems of the WPA program, recommended adoption of the merit system of employment, and emphasized the importance of local planning to insure profitable use of WPA funds and labor. Stanley H. Wright next presented concise data on the accomplishments of PWA and on its effects on direct and indirect employment. He then called attention to the disadvantages of working continuously under so-called "emergency" conditions, and stressed the need for a "reservoir of applications" for carefully planned public works in order to permit of a construction program easily adjustable to variations in the number of unemployed available. As the final speaker, Mr. McDonald drew the conclusions that relief spending will continue; that the continuance of "emergency" methods in meeting a no longer temporary condition is productive of waste; and that the real emergency now is the critical need for a national policy to control whatever expenditures there may be in the future for relief and public works. He concluded with a concise summary of the basic principles that should underlie such a policy.

All these addresses, in somewhat abridged form, are presented in the following pages.

Lessons from Emergency Unemployment Relief

By ROBERT L. MACDOUGALL

ASSOCIATE MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ASSISTANT ADMINISTRATOR AND STATE ENGINEER, WORKS PROGRESS ADMINISTRATION OF GEORGIA, ATLANTA, GA.

AS late as 1930, I was a rugged individualist, talking at length about new frontiers and believing implicitly that anyone who was willing to work could find a job. But in 1932, when I saw the national income drop below 40 billion dollars, and numbers of the best-trained, most efficient, and most energetic people in this country without jobs, I began to change my mind. It is easy to overlook problems of your neighbors and the entire community when your own future is assured by a good bank account and there is a demand for your services.

In midsummer 1933, when I obtained an administrative job in the public works program, I still felt that all this unemployment was somewhat temporary—that in time things would adjust themselves. But day after day men and women kept coming to my office with the same story—no money, no jobs, and no prospects of obtaining any in the future. Numbers of these people were known to me personally, and I was fully aware of their capabilities.

It is an undisputed fact that today there are no jobs available for many men able and willing to work, and this fact must be faced. For years, scientific and engineering research has been engaged in finding new methods of doing things that would increase production and lower costs. We have all seen these changes taking place, and we have rejoiced—and rightly so—in the progress that has been made. But this very progress has left us with millions of idle workers with no means of support—people who are potential producers of commodities that we need.

It has been our job as engineers for generations to take the resources of our nation and convert them into material things that make for better living, and we have in the unemployed the most vital resource of all—human effort. The job at hand is to create useful work for this labor when it becomes surplus to normal industrial needs in the various parts of the country. This is the most challenging task that we as engineers face today; and we must call on statesmen, economists, statisticians, financiers, and others to help us solve our problem.

Who are the unemployed and what can they do? Are they willing to work? We find from our WPA rolls that these millions of people are a cross-section of our American population who always have worked when they had an opportunity to do so; they are ambitious and seeking means of making a living. It is true that a lot of them after months and years of enforced idleness have lost their morale, and insufficient medical care and lack of proper food have impaired their health. But it is remarkable how rapidly these people respond to proper treatment, and the main medicine used in this treatment is a job that pays a living wage. I have personally seen thousands of American citizens respond to this treatment, and I know that they want to work for what they get.

I have grown tired of the hackneyed stories about shovel-leaning WPA workers, and about employers who want to give people work but cannot get them off "relief." As for this latter accusation, our records show that less than 1 per cent of the complaints are true. When we go to the root of the matter, in almost every instance we find that someone is trying to employ the workers at substandard wages.

LOCAL COOPERATION DEVELOPS USEFUL PROJECTS

I recall an incident in 1936, when a delegation came to my office complaining bitterly about the "reliefers" in their community. They stated that these men had been working half-heartedly on an airport project for months and were making no visible progress, and they wanted them either to go to work or quit. This delegation was composed of the leading citizens of the community, and I answered their question by asking them a few myself. First I asked who these people were. The answer was that some had come in to work in an industry that had

failed, others had drifted into the work program when local industry had been forced to lay them off. My next question was: Did they really work in private industry? And the answer was, "Why certainly!"

Then I told them that we had worked for months to try to get the local public officials to develop projects of a type that these men could do but had met with no success. The only thing offered was the airport job, and even then the local officials had insisted on an untrained politician to do the engineering work and expected us to do the job with hand tools when heavy machinery was required. The next step was to ask the delegation if they didn't have something that needed to be done in their city that these men could do—and immediately streets, schools, and sewers were suggested. I told them that the men would do the work if they would cooperate with the projects, and the deal was closed. Today this community boasts of a number of fine new public facilities, and the same people that criticized now have only the highest praise for the efficient and intelligent work that is being done. This same story has been duplicated in hundreds of communities.

RURAL SCHOOLS, COUNTY HOSPITALS, AND MUNICIPAL AIRPORT FACILITIES ARE AMONG THE MANY TYPES OF PROJECT MADE POSSIBLE BY THE WORK RELIEF PROGRAM

Long years of depression have resulted in a breakdown of apprentice training, and many young men enter the employment field without definite preparation. This is particularly true in the skilled crafts. With a low demand for skilled workers, the craft unions have in self-defense refrained from training new workers because it would mean more competition for them. This deficiency must be met either by job training in the work program or by the unions.

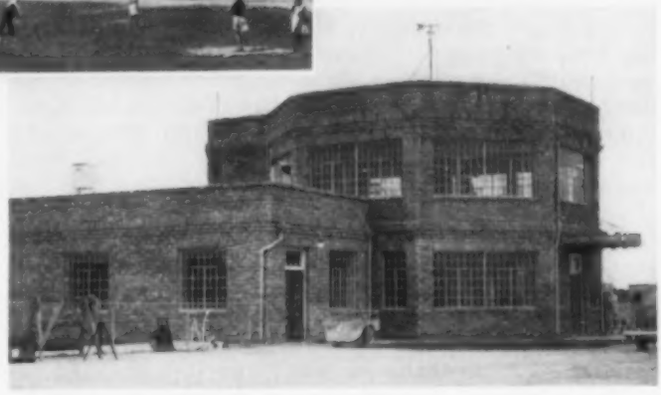
Displaced workers must be retrained for other gainful occupations, and experience shows that intelligent leadership in the work program has met this problem by developing projects to which this labor could become adapted.

The great majority of our population has no financial reserve; and when employment ceases it is only a matter of a few weeks until the family is in need. The longer this situation lasts the more acute is the suffering, and if permitted to go too far it results in the final collapse of the wage earner, both he and his family becoming public charges on our welfare agencies, hospitals, and other institutions. This is a public cost for which we get no return and spells tragedy to an American family.

When unemployment occurs in some section of the country, it is generally true that the local government is unable to meet the emergency—because only wage earners can pay the tax bills. Yet in every community there is plenty of work to be done which this labor can do. If then we are to face the problem of giving useful and needed work to the unemployed, there must be intelligent national planning, supported by local planning so that the jobs will be ready when the unemployment occurs.

Today in Georgia, the WPA projects are carefully planned months ahead, and the work done compares favorably with private contract work. If the Georgia program complied strictly with the terms of short-time appropriations, no planning ahead could be done—but common sense has dictated a more rational approach. Unfortunately, this planning is necessarily based on a mere assumption of continuity, and the results secured do not compare with those that could be gained if continuity were recognized as a fact.

Most of such planning as is now being done is furnished by WPA engineers, because they are charged with the responsibility of placing workers on the payroll. But how much better it would be if local projects could be planned by local people who know better than anyone else what is most needed in their community in the way of public building, sanitation, roads, water supply, recreation, conservation, health, and other programs. If such projects were thus planned in advance (probably with advice from the state and national planning agencies) they could readily absorb the unemployed when they became available and prevent costly delays and unnecessary expense.



In the present work program, when it was decided to give immediate jobs to the unemployed, we were all unprepared. For example, in Georgia we were asked to place 70,000 workmen in all walks of life on worth-while jobs within one week. The men were placed on the payroll within the time limit, but it took over a year to get the worth-while jobs, and naturally so, for there had been no advance planning. Still the critics always refer to this first year's work as a criterion of all WPA work.

PHYSICAL ACCOMPLISHMENTS OF WPA IN GEORGIA

The program today is manned by honest, capable engineers and other professional workers, and where proper cooperation is received from local officials, nothing but praise of it is heard. The local citizens see that they are getting needed improvements, and also that the money the WPA workers receive is immediately spent to the benefit of the entire community.

The huge proportions and the physical accomplishments of the WPA program may be illustrated by referring again to a single state. In Georgia it is currently employing over 60,000 men and women who have been

established as unemployed and in need of relief employment. Federal and local funds expended from the time WPA began, in July 1935 to the end of June 1938 totaled $66,756,828. Between January 1 and June 1, 1938, there were added to county highway systems 775 miles of improved farm-to-market roads. During the same period street improvement projects were carried out in fifty cities and towns; 109 public building projects were completed; and work was going forward on 56 additional projects in this classification, including schools, community buildings, gymnasiums, farmers' markets, and administrative buildings. Other projects under way include sewer and water systems, recreational facilities, and malarial drainage. In addition, white-collar workers have been employed to assemble valuable statistical data, and women have been put to work making garments for needy people, teaching the illiterate, and performing other useful tasks.

We must admit that these are all worth-while activities and that they have been going on for over six years at an enormous outlay of money. Should this continue on an emergency basis, or should the problem be recognized as being permanent?

Experience convinces me that financing a program of this kind must necessarily be done by the federal government, with funds allotted where needed. This, of course, means federal control of these funds, under which standard procedures and methods can be set up to cope with the many issues and ramifications of unemployment which extends beyond state lines.

The matter of who is to be employed and when has been determined by the social workers, and they, like the engineers, have had to adapt themselves to a field entirely new to them. The problem has been so great that trained personnel was totally inadequate and will continue to be if the investigation system is maintained, because of the rapid changes in employment.

The unemployed resent very much being subjected to questions relating to their resources and private lives, and frequently remain off work programs and undergo acute suffering rather than apply to the local relief office and have the stigma of relief attached to them.

It is a debatable question whether detailed investigating should be applied to the individual or to the community as a whole. Under the investigation system each applicant's home must be visited and a careful check made of his assets and needs. When a sudden large demand for labor occurs, it frequently happens that additional investigators must be employed and the necessary visiting takes several months. In the meantime the displaced worker must remain idle. Abolishing the means test would seem to be the ideal method, but the greatest objection to this seems to be the lack of funds.

POSSIBLE ADVANTAGES OF THE "JOB" METHOD

The method that might relieve the present situation, therefore, would be to abolish all investigations and have the unemployed apply to the WPA direct for a job, stating their financial circumstances; the workers would be drawn from the low income group. Thus the community would have a two-fold assistance—employment for its unemployed and distribution of funds through payrolls. As an incentive to return to private employment, the displaced workers could be paid the hourly prevailing rate for work done, with the hours of work limited so that the total earnings of the worker would be below the earnings in private industry.

It is true that this method would probably exclude the least efficient people in some instances because the alert workers would be the first to present themselves for jobs, but it would reach the proud workers who would not otherwise apply. We must allow for error in either method, but the job method we must agree is the quickest and the most American.

Our records show that in one instance a critical condition was relieved when pressure from the unemployed group became great and no time was available for investigation of the applicants. An estimate was made of the number of jobs required and applicants were taken from the registered lists without investigation and put to work. The demand immediately returned to normal, and a subsequent review of the cases eliminated only a normal amount of workers, which represented approximately the same number dropped in reviewing investigated cases.

Federal control under the present program has been in the main satisfactory. Politics has crept in occasionally, but the blame in almost every instance can be placed on local politicians, and this difficulty would be eliminated through the merit system of employment.

Lessons from Emergency Public Works Construction

By STANLEY H. WRIGHT
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
REGIONAL ENGINEER, REGION NO. 3, PUBLIC WORKS ADMINISTRATION, ATLANTA, GA.

THE Federal Emergency Administration of Public Works—the PWA—was born in June 1933. It has progressed in a sort of ant-with-grasshopper-legs manner from then until now.

Very briefly, the "a-b-c" of PWA procedure is as follows: (*a*) upon printed government forms applications are received for loans and grants, each or both for public projects, (*b*) these applications are examined for legal, financial, and engineering weaknesses—once in the field, and again in Washington, for a double check; (*c*) allotments of loans or of grants or both are made to eligible applicants. The applications are approved in from 6 to 60 or more weeks, in round numbers, subsequent to the completion of the examination—the excess time-out penalty being exacted while waiting for the next play to come out of the congressional huddle.

The peak volume of PWA projects from the standpoint of approvals has always been toward the close of each succeeding program, while the peak of construction has usually been reached, with the exception of the 1933 program, within ten months to a year following the approval peak. This has applied, generally speaking, to both the regional and national scenes.

Not the result of a five-year plan but rather of economic checkerboard strategy (which may have more quickly accomplished as much) is the chart of PWA

accomplishments. Up to October 1, 1938, that agency had allotted funds for public works in all but three of the nation's 3,071 counties, for

16,949 "federal" projects costing $1,757,628,296
17,231 "non-federal" projects costing $4,074,203,904

Of these, 25,568 projects costing over $3,400,000,000 had been completed and 2,745 projects costing about $1,360,000,000 were under construction. Expenditures on PWA projects up to that time included:

For wages	$1,210,786,981
For materials	2,188,121,571
Other	557,911,736
Total	$3,956,820,288

Man-hours of employment provided by these expenditures amounted to more than 8,800,000,000 divided as follows:

At site of construction	1,600,468,000
Production of raw materials, transportation, and fabrication	4,001,169,000
Supplying demands for consumers' goods and services	3,200,935,000

It should be understood that "federal" projects are those undertaken by subdivisions of the government itself, such as the Army, Navy, and Bureau of Public Roads, whereas "non-federal" projects are those undertaken by political subdivisions—states, cities, counties, and the like. It is the latter that come under the authority of regional directors and regional engineers. Prior to November 1, 1937, the Field Administration of PWA was handled through offices in each state. Subsequent to November 1, 1937, seven regional offices were established. This procedure logically followed the then supposed "liquidation" of the PWA, but the records would seem to indicate that the regional offices have not fallen short of the pace previously set by the state offices. Space does not permit presenting detailed data on the volume of work handled under the respective systems, but an overall summary of non-federal projects, by states and by districts, is presented in Table I.

TABLE I. SUMMARY OF ALLOTMENTS AND ESTIMATED COSTS OF NON-FEDERAL PROJECTS FOR ALL PWA PROGRAMS, AS OF DECEMBER 7, 1938*

REGION AND STATE	TOTAL			COMPLETED		UNDER CONSTRUCTION	
	No. of Projects	Allotments	Estimated Cost	No. of Projects	Estimated Cost	No. of Projects	Estimated Cost
Total	16,721	$2,118,702,976	$3,989,640,989	9,879	$1,691,925,574	4,359	$1,764,407,025
No. 1	3,118	688,287,417	1,375,149,683	1,922	536,642,834	771	700,529,896
Connecticut	262	27,926,364	69,696,419	204	29,769,736	42	30,379,192
Delaware	40	2,967,951	7,897,856	26	5,076,539	7	1,390,547
Maine	87	4,315,146	9,675,554	35	3,135,162	30	4,845,881
Maryland	142	31,721,977	69,742,831	83	16,980,838	40	39,971,230
Massachusetts	395	51,832,654	133,223,393	256	72,660,875	84	45,284,106
New Hampshire	114	6,815,408	15,870,144	74	7,754,420	19	4,122,680
New Jersey	317	58,014,971	101,764,524	195	41,801,634	74	48,755,267
New York	761	359,892,393	613,921,527	469	228,441,063	202	352,965,233
Pennsylvania	808	125,222,957	308,162,643	450	106,192,523	228	162,101,408
Rhode Island	87	16,023,207	36,750,682	62	20,441,017	16	8,742,419
Vermont	105	3,554,389	8,444,110	68	4,389,027	29	1,971,933
No. 2	3,445	444,910,934	853,260,220	1,902	336,291,749	990	362,830,382
Illinois	814	181,760,597	318,329,933	569	129,900,717	204	138,053,142
Indiana	489	42,787,269	90,983,335	282	43,453,841	118	33,333,928
Michigan	465	62,764,190	111,511,282	204	28,951,254	145	57,913,688
Ohio	1,063	102,566,772	209,364,318	530	92,627,999	373	80,216,826
West Virginia	152	19,566,639	38,336,140	91	7,967,582	32	21,341,088
Wisconsin	462	35,465,467	84,735,212	226	33,390,356	118	31,971,710
No. 3	2,839	286,862,829	504,359,718	1,600	188,657,158	773	231,355,012
Alabama	325	30,760,595	42,628,941	173	20,621,589	91	14,024,631
Florida	230	31,830,091	39,497,504	143	24,303,922	28	6,621,933
Georgia	527	20,096,764	39,452,829	255	17,520,727	144	9,939,105
Kentucky	301	25,197,267	50,394,316	168	20,315,521	74	23,822,162
Mississippi	230	34,117,060	67,403,095	145	10,836,670	44	37,664,811
North Carolina	356	38,561,717	61,773,748	188	24,483,872	118	21,177,845
South Carolina	244	39,062,478	78 266,642	161	17,826,741	62	54,087,661
Tennessee	280	36,648,199	67,872,306	170	26,820,174	78	37,452,463
Virginia	346	30,588,658	57,070,337	197	25,927,942	134	26,564,401
No. 4	2,636	217,742,349	408 584,822	1,531	196,166,978	618	154,055,624
Iowa	596	23,372,984	52,815,332	358	26,438,878	186	22,214,075
Minnesota	580	34,364,804	87,344,522	277	49,675,599	144	20,708,811
Missouri	569	48,280,402	122,999,709	293	59,334,184	146	47,889,978
Montana	160	19,766,546	26,423,924	108	15,066,097	40	7,756,546
Nebraska	310	73,260,218	85,568,451	210	24,535,965	35	48,548,161
North Dakota	195	6,501,908	13,248,651	128	8,039,508	25	1,507,914
South Dakota	168	7,547,879	12,226,829	125	9,433,154	20	1,385,009
Wyoming	58	4,647,608	7,957,404	32	3,643,593	22	4,045,130
No. 5	2,418	250,353,144	407,100,062	1,509	194,480,718	568	166,620,439
Arkansas	235	22,935,833	29,454,845	165	20,983,320	23	4,754,567
Colorado	203	20,901,016	47,383,560	110	30,083,188	52	9,593,806
Kansas	453	26,894,498	53,844,319	310	28,803,180	118	18,617,472
Louisiana	226	24,594,568	52,718,164	78	10,715,445	125	35,142,326
New Mexico	97	7,817,884	11,722,818	66	6,518,588	17	3,077,390
Oklahoma	303	38,528,211	51,822,777	202	20,799,739	48	26,931,249
Texas	901	108,681,134	160,054,579	578	76,587,258	185	68,503,629
No. 6	1,148	127,138,044	263,288,516	693	166,967,121	392	79,967,518
Arizona	122	11,952,215	17,711,706	64	9,022,955	57	8,608,751
California	801	104,163,024	224,916,624	484	145,193,648	278	64,629,639
Nevada	42	1,885,544	3,535,909	31	2,608,809	10	883,464
Utah	183	9,137,261	17,124,277	114	10,141,709	47	5,845,664
No. 7	983	59,184,500	124,547,288	671	64,274,690	203	43,169,262
Idaho	160	6,090,472	11,129,239	88	4,763,144	37	4,028,519
Oregon	295	17,075,552	30,276,944	153	17,138,649	74	7,972,444
Washington	495	34,037,617	80,376,790	411	40,839,878	81	30,087,912
Alaska	33	1,980,859	2,764,315	19	1,533,019	11	1,080,387
D. C. and Terr.							
D.C.	14	24,654,000	24,811,500	3	386,500	7	14,462,000
Hawaii	57	4,845,075	11,270,121	31	5,348,499	17	3,725,258
Puerto Rico	59	14,547,290	16,987,221	15	2,562,944	19	7,624,361
Virgin Islands	4	177,394	281,838	2	136,383	1	67,273

* Projects for railroad construction and low-cost housing excluded; Limited Dividend Housing projects included.

There has been some discussion on the types of projects conducted by PWA. In order to arrive at an intelligent understanding of the matter in hand and to enable the record to speak for itself, Table II, showing the extent and character of projects constructed since June 1933, is included herewith. It would seem scarcely possible to devise a public works program that would cover a more diverse field of engineering and construction.

The average "end-on-end" statistician could amuse himself for hours preparing little men and buildings to illustrate the construction figures. For example, if all the school buildings constructed in North Carolina with the aid of PWA funds were abutted wall to wall they would form a building in excess of eight miles long—and yet the school buildings in North Carolina are still overcrowded. There is no escaping from the fact

that most of the projects constructed under PWA will be serving a useful purpose long after PWA is gone and forgotten. But in spite of these accomplishments the question arises: Is there a need for long-range planning? If the answer is "Yes," what should constitute a rational procedure? And we may well ask each other whether there is need for a continuing government subsidy for unemployment relief and, if so, upon what basis.

If the object of the public works program is to provide employment and to stimulate or prime business activity, should we continue the present procedure as it relates to public works, or can we depend on private business to take over the whole burden?

EFFECTS OF PWA PROGRAM ON INDUSTRY

That industry has truly been stimulated by the PWA program is indicated by the fact that in almost all kinds of public works the cost of material exceeds the amount of money paid out in wages at the site. In average building construction, labor constitutes 28 per cent of the total outlay, material 55 per cent, and other expenses and profit 17 per cent. Orders placed for material on PWA projects totaled more than $1,700,000,000 in the four-year period from July 1933 to June 1937. These orders went to practically every line of industry in the country. Cement and steel, foundry and machine-shop products, and lumber products lead the list. Cement orders from PWA took 70 per cent of the entire domestic output in 1934; 37 per cent in 1935; and by 1936 had dropped to 17 per cent. In general, and in terms of millions of dollars, the materials ordered for the four-year period ending June 1937 were distributed about as follows (see U. S. Department of Labor Bulletin No. 658):

ITEM	MILLIONS OF DOLLARS
Cement, stone, clay products, glass, etc.	495
Iron and steel products	466
Transportation equipment	90
Machinery	292
Lumber	104
Miscellaneous	235

Figures 1 and 2, designed as progress charts, show indirectly the effect of public works construction.

The effect of PWA construction on direct and indirect employment and on business activity has been given careful study by the U. S. Department of Labor. Whether the motive power, that is to say the dollars, comes out of an arrangement between the PWA and its applicants or one between private industry and the nation at large, the results must be the same. It is stated that "on the basis of experience with hundreds of millions of dollars of construction, the Bureau of Labor Statistics developed fundamental ratios for determining the industrial and employable benefits which would result from an expenditure of $1,000,000 on each type of PWA project. For a $1,000,000 public building project, about 344,000 man-hours of labor would be created at the site. For the mining and production of raw materials, transportation, manufacturing, and distribution necessary to supply the needs of the $1,000,000 contract, 740,000 man-hours of indirect or 'behind-the-lines' labor would be required. Thus for the expenditure of $1,000,000 on a public building, a total of 1,084,000 man-hours would be created. Of the total only a part would appear directly at the site, the balance being spread through manufacturing, transportation of material, and in the administration of overhead. Thus, the expanding wave of employment would move out to many points in the industrial system. [In this connection see Fig. 3]... The analysis of cost on more than 1,000 completed non-federal projects indicates that the equivalent of the employment of one man for one month of labor at the site and on material can be provided by the expenditure of $136. Of this amount about $61, or 45 per cent, was provided by the federal government during the latter part of the PWA program, and $75 was paid by the community which undertook the project. This composite man-month of labor would be worked at the construction site or in a mine, forest, or factory, in the transportation and distribution of materials, or in the administration of the project." (In making this estimate, the Bureau based its figures on wages and working conditions prevailing in 1937.)

Thus, through measurement of the public works program, yardsticks

TABLE II. SUMMARY OF NON-FEDERAL PROJECTS, BY TYPES, FOR ALL PWA PROGRAMS, AS OF OCTOBER 31, 1938*

TYPE OF PROJECT	NO. OF PROJECTS	ESTIMATED COST	FUNDS SUPPLIED BY APPLICANTS†	TOTAL ALLOTMENT
Grand total, all types	16,720	$4,194,191,424	$1,870,822,130	$2,323,369,294
Streets and highways	1,528	467,791,952	262,120,612	205,671,340
Roads and highways	620	295,758,609	163,541,131	132,217,478
Streets	792	129,932,503	75,021,215	54,911,288
Grade crossing elimination	32	35,130,169	20,145,807	14,984,362
Miscellaneous	84	6,970,671	3,412,459	3,558,212
Sewers, water works, power, other facilities	4,665	941,393,772	388,608,578	552,785,194
Sewer systems	1,547	466,946,154	187,875,385	279,070,769
Sewer and water	197	23,805,611	6,425,555	17,380,056
Water systems	2,407	312,013,397	141,526,394	170,487,003
Garbage and rubbish disposal	41	10,909,406	4,289,404	6,620,002
Gas plants	26	1,860,700	406,294	1,454,406
Electric power excluding water power	298	98,093,978	35,444,094	62,649,884
Miscellaneous	149	27,764,526	12,641,452	15,123,074
Buildings	9,425	1,777,641,726	915,547,255	862,094,471
Educational buildings	7,244	1,157,295,155	583,139,631	574,155,524
Municipal auditoriums and armories	100	29,707,129	18,271,466	11,435,663
Courthouses and city halls	642	130,359,378	69,591,977	60,767,401
Hospitals and institutions	667	290,908,243	158,995,123	131,913,120
Penal institutions	176	36,131,245	19,959,262	16,171,983
Social, recreational buildings	136	18,441,768	9,484,912	8,956,856
Residential buildings	6	715,900	399,763	316,137
Office and administrative	134	34,186,912	19,297,009	14,889,903
Warehouses, laboratories, shops, etc.	87	12,127,891	5,833,714	6,294,177
Housing (limited dividend)‡	7	11,760,399	1,357,008	10,403,391
Miscellaneous	226	56,007,706	29,217,390	26,790,316
Flood control, water power, and reclamation	127	194,584,347	42,221,430	152,362,917
Dams and canals	32	18,298,977	2,121,346	16,177,631
Channel rectification, levees, etc.	3	477,831	48,403	429,428
Storage reservoirs	7	2,478,886	224,537	2,254,349
Water power development	13	77,698,980	8,573,827	69,125,153
Soil erosion	3	718,120	260,989	457,131
Flood control	26	89,597,739	29,005,525	60,592,214
Miscellaneous	43	5,313,814	1,986,803	3,327,011
Water navigation aids	45	20,140,424	8,211,368	11,929,056
Dams and canals	2	522,400	265,730	256,670
Channel rectification, levees, etc.	6	4,099,582	180,471	3,919,111
Other navigation aids	37	15,518,442	7,765,167	7,753,275
Engineering structures	477	466,512,346	192,318,977	274,193,369
Bridges and viaducts	380	227,410,310	94,829,259	132,581,051
Wharves, piers, and docks	56	29,440,142	12,291,666	17,148,476
Subways and tunnels	13	202,985,348	81,447,557	121,537,791
Other	28	6,676,546	3,750,495	2,926,051
Aviation	24	3,156,749	1,968,150	1,188,599
Recreational	143	24,101,609	8,609,063	15,492,546
Miscellaneous	254	97,893,999	51,216,697	46,677,302
Railroads	32	200,974,500	.....	200,974,500

* Projects for low-cost housing excluded.
† Does not include loans by PWA.
‡ Figures as of November 1, 1937, the date on which these projects were transferred to the U. S. Housing Authority.

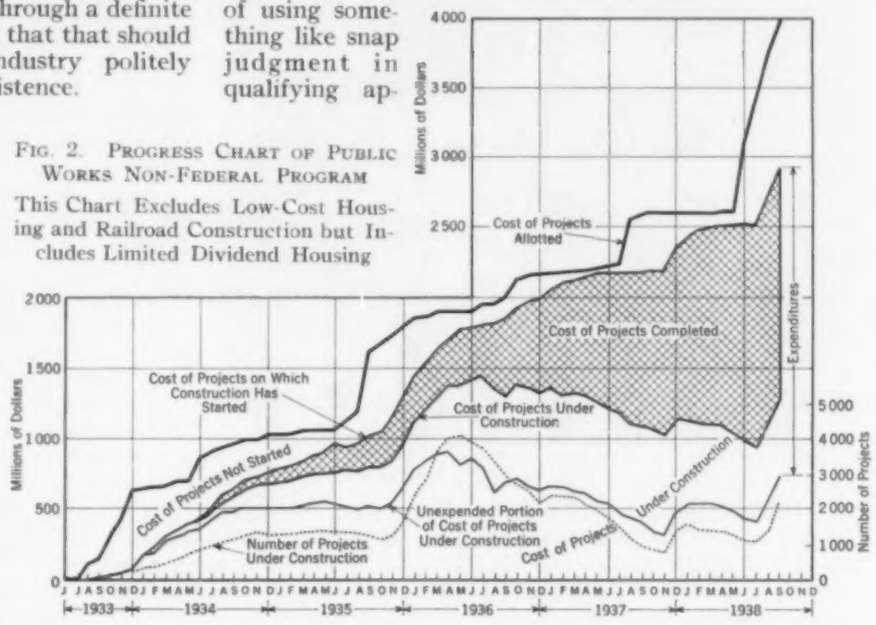
have been evolved by which the effects of future programs can be evaluated in advance. Proposed projects can be appraised "with a view to providing the wisest distribution of employment and the most effective use of labor."

If there is, as has been said, a national reservoir of unemployed, permanently existing in good times and bad, of as many as 3 to 10 per cent of the population, it would seem that it should be absorbed through a definite continuing program of public works, and that that should be done without government and industry politely thumbing noses over the cause of its existence.

There exists a peculiarly erroneous idea on the part of some that the Public Works Administration is a self-contained entity and is therefore subject to bureaucratic protection. Our aggressive Administrator has wisely made a special effort to eradicate bureaucratic tendencies on the part of his subordinates. The PWA exists only because of those who make applications for loans and grants. Since its inception, and up to September 30, 1938, a total of 37,271 such applications for non-federal projects had been filed. Approximately 10,000 of these applications were submitted in connection with the first program; approximately 14,500 were filed between April 8, 1935 (the date of approval of the Emergency Relief Appropriation Act of 1935) and June 29, 1937 (the date on which filing of new applications was prohibited by Section 206 of the Public Works Administration Extension Act of 1937); and 12,814 applications were filed after PWA was permitted to accept applications in preparation for the 1938 program. As a matter of fact, the PWA can exist only so long as applicants express a desire to participate in loans and grants, as well as a desire to conform to rules, regulations, and restrictions imposed upon them.

The primary sources of PWA applications include all the multifarious political subdivisions of the nation, together with the various federal units of the government itself. The need for financial relief in order to take care of local unemployment has of course been the primary objective leading to the creation of public works projects. But these projects have been sought not only for the relief of unemployment, but because of the definite need of communities for specific projects—projects in many cases long desired but economically impossible, until the advent of PWA with direct federal grants.

It cannot be said that the pressure of short-term programs has produced community projects that are unjustified or not useful. Every community structure or service financed by PWA has had a measure of economy of design, of economic justification, and has been reviewed in the light of the financial capacity of the community to pay for it. Granting this, we still must recognize that the intense method of handling hastily conceived projects places before overloaded personnel, private and governmental, the responsibility of using something like snap judgment in qualifying applications. Many communities, in their effort to aid the local unemployment situation, have made application for projects that could more readily be proved financially sound if presented at some later date. That this may be true is indicated by the fact that a rather large percentage of the applications have of necessity been rejected.


Millions of Dollars
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3 000
2 500
2 000
1 500
1 000
500
0
Cost of Projects Allotted
Cost of Projects Completed
Expenditures
Cost of Projects on Which Construction Has Started
Cost of Projects Under Construction
Cost of Projects Not Started
Unexpended Portion of Cost of Projects Under Construction
Number of Projects Under Construction
Under Construction
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Number of Projects
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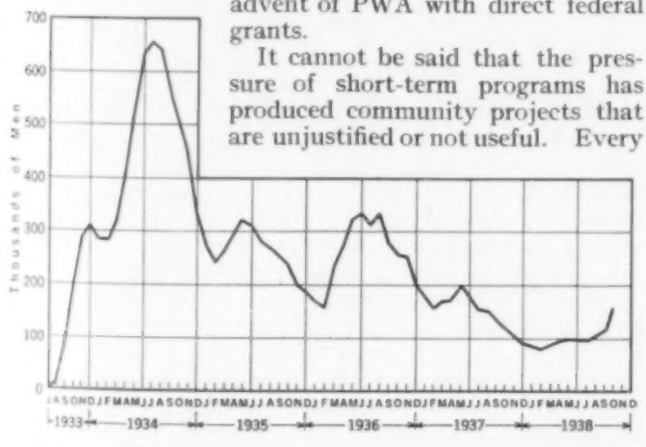
1933
1934
1935
1936
1937
1938

FIG. 2. PROGRESS CHART OF PUBLIC WORKS NON-FEDERAL PROGRAM
This Chart Excludes Low-Cost Housing and Railroad Construction but Includes Limited Dividend Housing


Thousands of Men
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1933
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FIG. 1. PWA EMPLOYMENT AT THE CONSTRUCTION SITES

Needless to say, the planning of local budgets is of scant value with intermittent programs like those of the last few years, under which funds required by an application presented today may not be called forth until a year or more has passed. Both budget and budgeteers may have disappeared with changing local regimes as elections take their toll. There is no question that some applications have been presented for projects without reasonable budgetary planning. As a rule this fact is brought to light by the PWA Examining Divisions, which recommend that many applications be disapproved. The same thing may be said of projects to which little study has been given as regards long-range requirements within the area covered. Many of these also are disapproved or returned to the applicants for more careful consideration.

Lost motion sometimes occurs because some applications require an act of the state legislature to ratify the necessary appropriation, or a local bond election to authorize the issuance of proposed securities. Not over 3 per cent of the allotments granted subject to such contingencies have been rescinded because of ultimate unfavorable action.

The speed and pressure required to shake off the grip of depression have resulted in a hasty, year-by-year appropriation system which, like almost any "emergency" activity, has its drawbacks. The present system, with its limiting time factors controlling especially the start of construction of all projects, encourages hasty designing, with its consequent risks and economic faults.

These forced-draft operations as a continuing process are—aside from the prospects of quick money—as unwelcome as a summons server to understaffed and overworked engineers and architects. The professional worker is not the only one to feel this pressure—applicants, contractors, and material men alike are keyed to a pitch of frenzy by the repeated tocsin of haste.

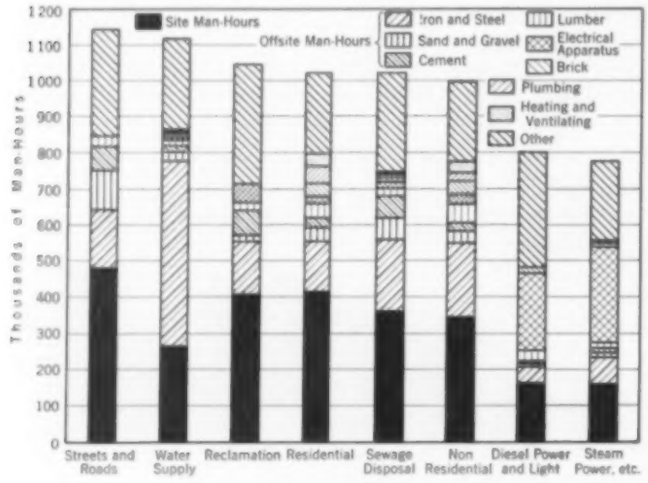

FIG. 3. SITE AND OFF-SITE MAN-HOURS PER MILLION DOLLARS EXPENDITURE, PWA CONSTRUCTION PROJECTS OF VARIOUS TYPES

Since public funds for proposed PWA projects are not usually available until allotments have been made in the form of loans or grants, the applicant cannot obtain professional advice or proceed with a thorough investigation of the site prior to submitting an application, unless the engineer or architect accepts a small retainer or gives his services for a contingent fee. Even in these cases the degree of professional service rendered is apt to fall short of requirements, especially where large bridges, complicated public buildings, and like structures are concerned.

Thus time restrictions and financial considerations are the principal factors contributing toward uneconomic design and performance. It becomes apparent that time, energy, and funds can be conserved through long-range planning of useful public works.

Unfortunately the unemployed, like the poor, we have always with us in some percentage from 3 to 30. This store of human energy must not be transformed into political cannon-fodder. Hence it would seem that if PWA is to continue it must proceed through the medium of careful planning, which should give first consideration to anticipated wants in relation to the anticipated number of unemployed available, as indicated by the industrial production barometer.

There must be a reservoir of applications for works that have been planned technically and financially to meet a definite need. Laying the ground work for long-range planning, the Administrator created the National Planning Board, which was first started and financed by PWA. From this has grown the National Resources Committee. The latter has given a great deal of time and attention to building up an elaborate schedule of needed public works throughout the country. While it is true that this schedule has not been followed as closely as could be desired, it has to some extent influenced the selection of PWA allotments. Water projects, for example, must have the approval of the National Resources Committee before an allotment is made. This is to assure a properly coordinated development of our water resources.

It must appear that the creation of various governmental technical committees or boards indicates a recognition of the need for long-range planning and perhaps a permanent public works program. In the writer's opinion, credit is due Administrator Ickes, who has made progress in the right direction under difficulties such as administering an emergency program with a dead-line date.

It is not the purpose of this paper to measure the route or degree of success of the various vehicles used to date. Rather it is intended to direct attention to the remarkable achievements attained under the most difficult emergency conditions, and to indicate that from an engineering standpoint it may be time to emerge from emergency, and to recognize the need for long-range national planning for public works.

Toward a National Relief and Public Works Policy

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IN his recognized function of adapting nature's resources to the uses of mankind, the engineer becomes the trustee of the natural resources of the nation. It would be a breach of this trusteeship if the engineer did not hold public waste to so undermine the gainful use of our nation's resources as to impose a clear duty upon all citizens to seek rational procedure in public expenditures.

The long duration of the nation's "emergency" support of the unemployed and of its "emergency" stimulation of public works to create employment, proves that these are no longer temporary or emergency provisions. Yet the illusion of "temporary" continues—with a consequent prolongation of "emergency" assumptions that is resulting in waste.

The justification of relief spending is not up to us as engineers. That choice is for the people, through their elected representatives. But it is the duty of the engineer to place his experienced judgment at the disposal of the nation in determining the most effective use of the nation's resources in material and labor. The identifying of conditions that hamper a sound use is as much an engineering responsibility as is the portraying of conditions that will permit the soundest use. As engineers, we must accept both of these responsibilities.

Unexpected events bring emergencies; and emergencies can bring a panic that makes men grab at straws. This was the national psychology created by unexpected economic events from the fall of 1929 to 1932. It was the psychology that supported the first federal moves in 1932 to aid an army of the hopelessly unemployed, by temporary support, while undertaking to create work opportunity. The need then seemed too critical to hazard the seeming delay of planning. Unstudied poli-

cies were launched overnight. This emergency concept has continued until it has created a national paradox. A series of budget-breaking expenditures has been stamped as "temporary" year after year, with no end yet in sight.

Whatever the emergency aspects of 1932, 1933, 1934, and 1935, by the time we add 1936, 1937, 1938, and 1939 we must pause before 1940 at the ringing of familiar notes. True, the condition that once caused a panicky alarm does still exist. But the continuance of emergency methods in meeting a no longer temporary condition implies a national delusion. If we continue our relief spending at all, we must recognize a continuing problem that is no longer subject to the irrationalities excusable only in real emergencies.

Relief spending to some degree will continue. We may decrease our spending, but we cannot refuse abruptly to spend today for what we have so unquestionably accepted for nearly ten years as a public charge. Inescapably comes the question—"Does continuing mean permanent?" The answer must come from the facts.

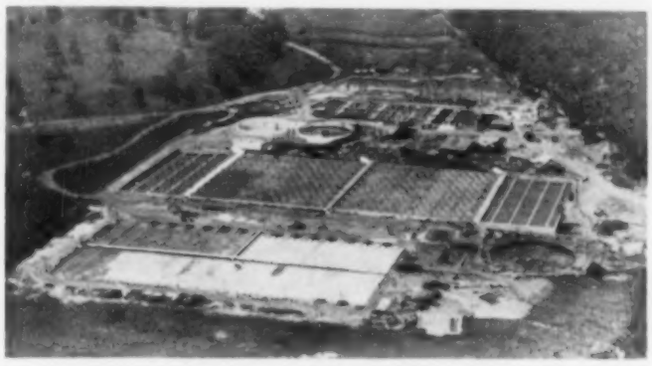
FACTS ABOUT UNEMPLOYMENT AND PUBLIC WORKS

The facts as to unemployment are that we always have had a certain number of temporarily, habitually, or cyclically unemployed workers; and the prospect is that we always will have unemployment in varying degrees. The only change today is public recognition and acceptance of responsibility. The support of the unemployed has been transferred from a direct charge on scattered private purses to a segregated relief load accepted as a public charge. Who in this nation today will revoke the public acceptance of this charge and throw this reservoir of idle workers back to dependence on private purses? Tomorrow perhaps, but not today—and in the meantime the cost continues.

The facts as to public works, also, are that we always have had and always will have them. Our cities and our countryside have been made habitable and safe by public works; and the prospects are that we will always have to rely on works at the public expense to supply the general conveniences of communal living. The only change today is the recognition that public works are the one form of work creatable merely to meet employment needs, instead of economic demand. It is the only form of "made work" that will not compete with and destroy the private enterprise which supports the nation and its government. Who in this nation today will deny the good sense of capturing permanent benefits from labor supported at the public expense by using this labor to create some degree of new wealth in public facilities? Unless we are ready to qualify our obviously continuing relief expenditures by requiring the enforced idleness of all able-bodied workers who receive support at the public expense, we must continue public works expenditures to some extent to create work opportunity.

THIS PROJECT, BUILT WITH WORK RELIEF LABOR, WILL MAKE FOR JOB-SECURITY IN YEARS TO COME

One of Four New Buildings for Georgia State College, Which Provides Industrial Training for Negro Youth



INTRENCHMENT CREEK DISPOSAL PLANT

Built by WPA and the City of Atlanta, This Plant Has a Maximum Capacity of 28,000,000 Mgd

Our instinctive emergency action to meet a sudden national need has brought about a conjunction of two continuing factors in our social structure. Unemployment has sought public works for the creation of economic stability. Once having accepted the unemployed as a public charge, the problem of finding ways and means to carry the burden will be a continually recurring one in our national policy.

The question of relief and employment spending has become a permanent national problem.

For sanity's sake, we must begin some conscious measure of the elements of this problem. The controlling elements are "budgetary," "justification," and "timing." The first has to do with "capacity to pay"; the second calls for a measure of necessity; and the third is a question of "when."

Until now we have disregarded our capacity to pay; we have let justification become confused with wishfulness; and we have given no more attention to timing than to grab at the biggest possible expenditure—for the next time.

The cost has been tremendous. The seeming gains have been large. But the obvious losses must be emphasized from continuing appropriations styled as "emergency," each bearing the paradoxical stamp of expiring forever on June 30 of its current fiscal year—or sooner.

These emergency assumptions have provided little basis for the studied use of funds or of labor; for the studied development of communities and areas; or for the planned use or selection of administrative personnel in handling funds and projects.

Obviously, the volume of idle labor could be little diminished where no concerted plan existed for the utilization of technologically displaced workers, or for the shaping of young men to meet the projected needs of changing industry and the growing deficiency in skilled artisans. Construction employment has had to depend too much upon the desperate creation of hasty local projects. As a result, there has been little projection of

NEW BRIDGES FOR OLD ON FARM-TO-MARKET ROADS
In Georgia Alone 4,000 Miles of Secondary Road Have Been Built or Improved by WPA

long-range local programs based on studied budgets or the area-integration of facilities; and proper planning and design have suffered on projects forced into construction under arbitrary date limitations. There has been excess cost in material, labor, and contracts, resulting from the pyramiding of demand that always comes from the piling up of peaks of construction. There have been such differences of policy, on the part of our spending agencies, as to provide the spectacle of loans being denied against questioned collateral tendered by communities promising repayment, while money was being given for similar purposes to other communities with no collateral and no repayment required. And periodically there has been a hectic and forced-draft administration by all of our spending agencies, with a fluctuating, over-worked, and overstrained personnel.

Succeeding doses of feverish activities labeled "temporary" have bred a chain of hectic cycles in a program seeking stability.

If we are to continue to have labor supported at the public expense, the only non-disturbing use of this labor is in public works. Then we must awake to the fact that over some period of the future there will be many workers available for the construction of public works.

Until now, our local public works programs have resulted only from grudging compromises between the self-protective instincts of taxpayers and the crying needs of communal living. Our communities have grown haphazardly. They are filled with crazy inconveniences and unsafe makeshifts. At last the man-power is on tap to utterly change the complexion of our communities at no labor cost, since available man-power already is supported at the public expense. Common sense dictates that this man-power be used effectively to achieve carefully planned results.

"AN UNPARALLELED OPPORTUNITY"

Actually, we face an opportunity unparalleled in the history of the world for the immediate projection over long periods of bold concepts for the betterment of our communities in terms of the most enlightened social and scientific values.

The moment we become frankly aware that the qualifying terms "emergency" and "temporary" have evolved into "continuing," we can claim rationality only if we begin some studied planning of policy.

What is planning?

Planning is the projection of objective and procedure in terms of economy and effectiveness. These require that we find what we want to do, the manner of doing it, and with what means it is to be done. These elements constitute a policy.

To underlie a national policy for the relief of the unemployed, I submit three simple principles: first, that of "need," for eligibility; second, that of justification, in spending; and third, that of non-political operation. Eligibility for relief must be based on need and neither granted on political preferment nor denied because of lack of political compliance; administration must be free of calculated political advantage; and the use of public money must meet the same requisites of capacity and economy that its spenders would insist upon if the money came directly from their private purses—since there is no such thing as "public funds" other than those that come from private purses of citizens.

In determining a national policy of using public works to create employment and to recover values from the public support of able-bodied workers, I submit three basic needs: first, to determine the budgetary capacity of local, state, and federal agencies over long periods of time; second, to identify the character of facilities for which such budgets rationally may be drawn upon and the justified rate of expenditure; and third, to stimulate a policy of advance planning and design, combined with a flexible program of execution that will so "time" the building of public projects as to meet to the maximum the current problems of unemployment.

Only by projected planning, with advance provisions for financing and with advance design, can delay in the creation of employment through public works be avoided, and quick adjustment to changing employment needs be assured. Only by such careful planning can a rational integration of public needs with capacity to pay be worked out even when employment is not the specific objective.

To make possible the meeting of these needs, I submit the following as a necessary public concept. The projected planning and financing of local and regionally integrated public facilities is as much a responsibility of local, state, and federal governments as is the now accepted cost of the detailed design of such facilities; and every unit of government must create an adequate budget for some kind of continuing authority to project and plan its physical conveniences ahead of the moment of need.

The future begins now. From a decade of hurried procedure in relief spending, based on emergency viewpoints, have come enough seeming benefits to baffle us for an alternative and to create doubt as to the possibility of terminating such spending. The program will continue—to some degree. But its extent and the manner of its continuance now must be based on a new emergency—the admission of an emergency status precedent only to a study of policy, and tolerable only for the shortest interim necessary to evolve rational procedure.

We do not have to fear any current relief and employment appropriations as an index to a permanent basis for such spending—if we have a policy to guide us. We can always let current conditions determine the size of appropriations or whether there will be any appropriations at all. What we now have to do is honestly to face the fact that our originally temporary viewpoint is no longer applicable—and determine the conditions under which we are to treat a continuing problem.

Against the national illusion of continuous "emergency" spending to meet presumed "temporary" conditions that persist, must be placed the engineer's view that our real emergency is the critical need for a national policy to control whatever future expenditures there may be for relief and public works. Such a policy must capitalize every element into non-political assets, gained with economy from justifiable drafts on the private purses of our citizens.

Entrainment of Air in Swiftly Flowing Water

Observations of the Flow Over Spillways Yield Conclusions of Interest to Hydraulic Engineers

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AIR entrainment in swiftly flowing water may upset the most careful computations of stilling-basin or chute capacity, by reducing the velocity of flow and increasing the volume of water. Few quantitative data on the phenomenon are available, and Professor Lane's observations on the factors causing it should point the way to more intensive investigations.

KNOWLEDGE of the laws governing the entrainment of air in swiftly flowing water is of importance in the design of overfall spillways and steep chutes. If the water flowing over an overfall spillway absorbs large quantities of air, and thereby has its velocity greatly reduced, the design of the stilling pool below the dam may have to be very different from a design based on solid water. If water flowing down a chute absorbs air, the volume of the water will be increased and higher sides will be necessary on the flume than would be required for solid water. If the entrainment of air causes a greater reduction of velocity than would be estimated by considering only the friction of the water on the bottom and sides of the flume, still higher side walls will be required.

In recent months the writer has given considerable thought to this problem and has observed a number of cases of water flowing at high velocity in chutes and dam spillways. He has also examined a number of photographs of such flows and as a result has arrived at the conclusions given in this article.

Consider first the case of a steep channel so wide that side effects may be neglected, with entrance conditions such that the water enters the channel without disturbance. A common example of this case occurs where water flows over the long, smooth, rounded crest of a dam, with a low velocity of flow upstream from the dam. In passing over the crest the water near the surface accelerates very quickly and smoothly, and except for a few small ridges has a glass-like surface. If the water is clear the surface of the dam can be seen as distinctly as if the water flowing over it were not in motion at all. This transparency continues some distance down the face of the dam, the distance depending on the depth of the water, the roughness of the surface of the dam, and the quietness of the flow approaching the dam crest.

As the distance below the crest increases, the image of the dam surface becomes more and more distorted—because of the increasing roughness of the water surface—until it can no longer be seen. At this point boils appear to break through the surface, raising part of the water somewhat above the average surface level in the form of temporarily projecting masses.

The air immediately adjacent to the smooth-flowing water is no doubt carried along at a velocity approaching that of the water, but a short distance above the water surface there is probably little movement of the air, as sufficient time has not elapsed for the drag forces exerted by the water to take effect. The projecting masses of water, which are moving at a high velocity, rise up into this slowly moving air, which greatly resists their motion—to such an extent that they break up and mix with the air. When they fall back into the main stream, they carry with them air in the form of bubbles, giving the stream a whitish appearance. As the water flows further it collects more and more air, and assumes an increasingly white color, until a condition of equilibrium is reached where the amount of air escaping from the water equals the amount of air being mixed into it. The whiteness of the water is therefore a rough indication of the amount of air entrained.

The projecting bodies of water previously mentioned are caused by the turbulence set up at the lower surface of the moving stream by the roughness of the dam surface. This roughness causes some of the water to move away from the bottom at an angle with the direction of the main flow, in the same way that the familiar boils are produced in flowing streams. Near the top of the dam these turbulent currents are not so severe, as their transverse velocities tend to be proportional to the longitudinal velocities. They do not disturb the water surface in this region because while they are moving from the bottom toward the surface they are also being carried rapidly downward by the main current, so that they reach the surface some distance below the dam crest. The first cross currents to reach the surface are not very severe, as they are generated by the low velocities at the

FIG. 1. FLOW OVER DAM AT UNIVERSITY OF IOWA LABORATORY

In (*a*) and (*b*) There Are Flashboards on the Crest. The Quantity of Flow Is Approximately the Same in (*a*) and (*c*), and Somewhat Lower in (*b*)

crest, but those started further down, where the water is flowing at higher velocities, are characterized by increased violence. In rivers the upward velocity of the boils is ordinarily not sufficient to carry the swirling masses of water much above the general surface of the stream, and on reaching the surface they spread out in a thin layer. However, in water flowing down the face of a dam, where the longitudinal velocities are much greater than in a river, the transverse velocities are proportionally greater. Some distance below the dam crest the transverse velocities may be sufficient to cause masses of water to move out a foot or more from the main body, causing a mixing of water with air as previously described.

Turbulence in water passing over a dam may be due to important factors other than friction on the dam face. In such cases air entrainment will take place sooner than where friction alone is present. Such factors may be flashboards on the dam crest or conditions causing turbulence in the water as it approaches the crest.

FIG. 2. DISCHARGE OF 13,000 CU FT PER SEC OVER NORRIS DAM
Note Height to Which White Water Extends Up the Face

Whether or not the water flowing down the face of a spillway becomes charged with air therefore depends upon at least four factors: (1) the turbulence set up on the dam crest or upstream from it, (2) the roughness of the surface of the dam, (3) the thickness of the overflowing sheet, and (4) the height of the dam. The rougher the surface of the dam the more violent will be the turbulence set up and the rougher will be the water surface, hence the greater will be the amount of air entrained. The thicker the sheet of water passing over the dam, the greater the distance the water will flow down the face of the dam before air entrainment begins. If the dam height is less than that required to produce entrainment with the given conditions of roughness and overflow depth, no air will be taken in, but if the height is greater than this amount, air will be entrained and the amount will increase with increasing heights up to the height that produces equilibrium.

The effect of dam roughness and depth of overflow are well illustrated in Figs. 1 (*a*), 1 (*b*), and 1 (*c*), which show water flowing over the dam at the University of Iowa laboratory. When Figs. 1 (*a*) and 1 (*b*) were taken, there were flashboards on the crest, which produced considerable turbulence, such as would occur with a very rough crest. In Fig. 1 (*c*), the discharge was approximately the same as in Fig. 1 (*a*), but there were no flashboards. Consequently the surface of the flow is in the form of a smooth sheet, while in Fig. 1 (*a*) it is quite rough and the turbulence bodies can be seen distinctly as they break through the surface. In Fig. 1 (*b*) the depth of overflow was less than in Fig. 1 (*a*), and the turbulence breaks through more frequently, causing a much rougher surface. In neither Figs. 1 (*a*) nor 1 (*b*) was much air entrained, as the velocity of the water was not high and the mixing of air with water was just beginning to a visible extent when the flowing water reached the level of tailwater.

In Figs. 2 and 3 are shown discharges of 13,000 and 30,000 cu ft per sec, respectively, over Norris Dam. It will be seen from Fig. 2 that with the smaller discharge a large entrainment of air, as indicated by the whiteness of the water, takes place before the water has fallen halfway down the spillway face. With the greater discharge (Fig. 3) the water is comparatively free of air until it gets nearly to the bottom of the spillway. (At the greater discharge there is some localized air entrainment high on the face, as shown by the spots of white water in the photograph. This is due to the fact that the water forms ridges as it flows down the dam face and these are broken up by the resistance of the air in places where they have become thin. In both Fig. 2 and Fig. 3 there is also local air entrainment caused by the piers on the dam crest.)

FIG. 3. DISCHARGE OF 30,000 CU FT PER SEC OVER NORRIS DAM
There Is Localized Entrainment but Water Is Completely White Only near the Bottom of the Dam Face

In Fig. 4 a flow of 16,100 cu ft per sec is passing over one gate of the Madden Dam, the depth of flow on the crest being 12.9 ft. Here no appreciable entrainment is taking place throughout the entire drop. The pattern of the concrete face was faintly visible through the flowing water over the whole face where the flow was not disturbed by side effects. Local entrainment occurred along the surface ridges, as at Norris. A photograph of the flow at the foot of the dam when the depth at the crest was about 7.8 ft shows considerable air entrainment ("Hydraulic Tests on the Spillway of the Madden Dam," by Richard R. Randolph, Jr., PROCEEDINGS, American Society of Civil Engineers, May 1937, page 880). A comparison of photographs of flows over the Willwood Dam at different crest depths also shows more entrainment at lesser depths ("Construction of the Willwood Diversion Dam," by Ivan E. Houk, M. Am. Soc. C.E., *New Reclamation Era*, February 1928, page 28; "New Design Features in Willwood Diversion Dam," by Ivan E. Houk, *Engineering News-Record*, Vol. 99, October 27, 1927, page 661).

An examination of these photographs indicates that even on very high dams where the concrete surface is smooth, air entrainment is not likely to be great if the depth at the crest is considerable.

Air entrainment sometimes occurs beneath the flowing stream, as has been pointed out by G. H. Hickox, Assoc. M. Am. Soc. C.E. ("Performance of Norris Stilling Basin During 1937 Flood," Tennessee Valley Authority). For example, when the water flows over the lip of a partly open drum gate and falls freely in air to the surface of the dam, air is trapped beneath the flowing stream and, in escaping, rises through the flowing water and causes more active projecting turbulence bodies and therefore greater entrainment a short distance below the point of entrap-

ment, than is produced by the roughness of the dam surface alone. The turbulence thus introduced probably also causes more entrainment even after the trapped air has escaped.

Entrainment of air in high-velocity chutes follows the same laws as on overflow dams, except that in the former case the effect of the sides may be important. Figure 5 shows the flow down the chute spillway of the Alcova Dam. The smooth water near the top of the chute gradually gives way to surface roughness followed by increasing air entrainment. The turbulence bodies springing out from the main mass and being broken up and mixed with air are plainly seen. The mixing with air that occurs in the highly turbulent zone along the sides has been previously pointed out ("Recent Studies on Flow Conditions in Steep Chutes," by E. W. Lane, *Engineering News-Record*, Vol. 116, January 2, 1936, page 5). In wide chutes such as the Alcova spillway, the sides have little effect, but in a narrow flume their effects may be of major importance. Conditions at chutes are frequently such that turbulence is set up in the water as it enters the chute, and this often considerably increases the air entrainment.

FIG. 4. FLOW OF 16,100 CU FT PER SEC OVER ONE GATE OF MADDEN DAM, WITH DEPTH AT CREST 12.9 FT
No Air Entrainment Is Visible Over Whole Height of Dam Face, Except for Side Effects

Air entrainment is likely to be of more importance in the design of chutes than in overfall dams for the following reasons: (1) the depth of the water in flumes is usually less than that over dams; (2) flumes are frequently longer than dam faces, giving more time for turbulence effects to reach the surface; (3) side effects are likely to be more important in chutes; and (4) entrance conditions are frequently such that turbulence is introduced.

Experiments by Ehrenberger (*Osterreicheschen Ingenieur und Architektenvereines*, Nos. 15–16 and 17–18, 1926) in a flume 0.82 ft wide, with discharges up to 1.57 cu ft per sec, have led to the belief that air entrainment begins at a velocity of about 10 cu ft per sec and that velocities might reach an upper limit of about 80 ft per sec. ("Hydraulic Knowledge," by J. C. Stevens, M. Am. Soc. C.E., *Engineering News-Record*, Vol. 120, February 10, 1938, page 237.) From Figs. 3 and 4, together with photographs published elsewhere, Table I has been compiled, giving for a number of dams approximately the distance down from the reservoir water surface at which appreciable entrainment appeared to begin at the discharges observed, and the velocity for free fall corresponding to this height. In cases where the point of beginning of entrainment does not show in the photograph, the distance given is the greatest distance shown on the photograph. Such measurements are followed by a plus sign, indicating that the distance that would cause entrainment would be greater than that given. Although the actual velocities were probably somewhat smaller than those given in Table I, they undoubtedly were considerably in excess of 10 ft per sec. While the velocity of flow is probably a factor, since with high velocity the projecting turbulence bodies meet with greater resistance from the air and therefore mix more rapidly with the air, it may be safely concluded that air entrainment does not always begin at a velocity of 10 ft per sec—or at any other fixed velocity.

TABLE I. DISTANCES BELOW RESERVOIR WATER SURFACE, FOR VARIOUS DAMS, AT WHICH APPRECIABLE AIR ENTRAINMENT BEGINS FOR A GIVEN VELOCITY OF FALL

DAM	DISTANCE DOWN TO ENTRAINMENT, FT	CORRESPONDING VELOCITY OF FREE FALL, FT PER SEC	REFERENCE
Norris	120	88	Fig. 3
Madden . . .	145	96	Fig. 4
Gatun	65+	65	*Eng. News-Rec.* Vol. 94, Feb. 5, 1925, p. 244
Triunfo Creek .	40+	51	*Eng. Rec.*, Vol. 71, June 19, 1915, p. 775
Schuylerville	25+	40	*Eng. News.*, Vol. 53, April 27, 1905, p. 449
Dnieprostroy .	100+	80	*Eng. News-Rec.* Vol. 109, July 21, 1932, p. 90 CIVIL ENG., Vol. 1, Feb. 1931, p. 390
Bassano . . .	40+	51	*Eng. News*, Vol. 72, August 27, 1914, p. 429
Grand Lake .	50+	57	CIVIL ENG., Vol. 1, Feb. 1931, p. 390
Chute à Caron	140+	95	CIVIL ENG., Vol. 3, Oct. 1933, p. 567

The belief that there is a maximum velocity of about 80 ft per sec for water flowing down a steep channel does not seem to have much justification. An automobile coasting down a hill attains a maximum velocity, and a parachute jumper falling in air before the parachute opens also does, but in both these cases it is because the resistance to high-velocity motion becomes equal to the component of weight of the falling body in the direction of motion. In a chute with uniform slope, if long enough, for a given flow a point would be reached where the resistance of the air plus the resistance of the bottom and sides would be sufficient to balance the component of the weight of the water acting in the direction of flow, and no further increase in velocity would take place. However, if the depth of flow were sufficiently increased by increasing the discharge, the amount of air entrained would be reduced, and the other resistances would also be relatively less, with the result that velocity would increase.

FIG. 5. FLOW DOWN CHUTE SPILLWAY OF ALCOVA DAM

The author is indebted to the engineering organizations of the Panama Canal and the Tennessee Valley Authority for photographs of the Madden and Norris dams, respectively, and to G. H. Dunstan, Assoc. M. Am. Soc. C.E., for photographs of the Iowa City Dam.

Dam Foundation Compacted by Pile Driving

Settlement Observations Yield Quantitative Data on Consolidation of Dredge-Placed Sand Fill

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LOCK and Dam No. 3, about 6 miles upstream from Red Wing, Minn., is one of a series of 26 locks and dams which have been or are being constructed in the Mississippi River between Minneapolis and St. Louis. The dam consists of (1) a movable-gate section with an over-all length of 365 ft, supported on a timber and steel-piling foundation; (2) an abutment at each end of the movable section constructed of sand fill held in place by steel Z-pile walls tied together with tie rods; and (3) two sections of earth dike totaling approximately 4,000 ft in length.

GENERAL VIEW OF DAM FOUNDATION PRIOR TO DRIVING PILES

Prior to construction, exploratory borings revealed an unusual and very serious foundation condition in the area of the movable-gate section—a soft, plastic, silt deposit about 15 ft thick, with its upper limit only a few feet below the proposed base of the roller-gate pier footings. This material unquestionably could not have supplied the necessary resistance to lateral movement of the foundation piles.

Various methods for providing a suitable foundation were investigated, and it was finally decided that the most economical procedure would be to remove the silt layer by dredging and then to backfill the area with suitable sand obtained from an adjacent surface deposit. This work was done by the United States, before the contract for construction of the dam was awarded. A 15-in. hydraulic dredge was used both for removing the silt and for placing the backfill sand. The latter material was deposited directly from the discharge pipe of the dredge, the material settling through about 40 ft of water.

AUGERS PLACED TO DETERMINE AMOUNT OF SETTLEMENT

Available information on the placement of sand fills in water indicated that the backfill as placed was in a very unstable state. However, reliance was placed upon the vibratory forces resulting from driving the foundation piles to cause the desired consolidation. In order to determine, in the field, whether such consolidation was actually taking place, earth augers were placed in the subsoil after the cofferdam had been unwatered, and their settlement during the pile driving operations was carefully observed.

The augers were of a standard make with an 8-in. blade and a 24-in. shank. As shown in Fig. 1, they were placed in rows of 10 each along the center lines of Piers 2, 3, and 4, and Sills 2 and 3. Prior to driving piles in a given area, the settlement augers were turned into the subsoil until the top of the 2-ft shank was approximately 1 ft below the designed subgrade elevation. In some instances where there was considerable material above subgrade elevation it was necessary to place them temporarily at a higher elevation, and remove and reset them as grading progressed. As each auger was set, an initial reading was taken on the top of the shank, which was then covered with a small wooden box for protection. Subsequent readings were taken at intervals of approximately one week, throughout the period in which piles were being driven within an effective distance.

More augers were installed than were actually necessary because it was realized that some of them would probably be lost during the pile driving operations. This supposition was borne out, the losses being caused mainly by the jetting which was required in some areas to drive the piles to the required penetration. Care was also taken in locating the augers to see that none were placed at the toes or on the slopes of eroding berms; this eliminated the possibility of lateral movement and consequent erroneous readings.

The results of the final observations, in the form of lines drawn through points of equal settlement, are shown in Fig. 1. Data from 44 of the original 60 augers were believed to be accurate enough to take into account in the construction of these lines.

Attention is called to the fact that a group of 10 augers were first placed in an area downstream of Pier 4 in which test piles were driven previous to the driving of the remainder of the foundation piles. The lines drawn through points of equal settlement in this area indicate the effect of the pile spacing; the greatest settlement occurred where the piles were spaced at 3-ft centers and the settlement decreased where the pile spacing increased.

As it was impracticable to place augers over the entire area affected by pile driving, the area between the center lines of Piers 2 and 4 was used as a basis for the subsidence calculations. Referring again to Fig. 1, the areas within the lines of equal settlement were measured by planimeter and the total loss in yardage between the center lines of Piers 2 and 4 was computed to be 880 cu yd. From the lines of equal settlement it was also determined that the total area affected was approximately 44,690 sq ft. The average settlement was thus 0.53 ft.

To confirm these results, an attempt was made to measure the subsidence of the foundation sand by comparison of accurate cross-sections taken prior and subsequent to pile driving operations and including the entire area within the cofferdam. During construction, the yardage of any material deposited in or removed from the cofferdam area was carefully estimated and was added to or subtracted from the difference in yardage as determined from the two sets of cross-sections. This difference

indicated a settlement loss within the cofferdam area of approximately 2,600 cu yd. In determining the approximate average settlement, it was assumed that the average width of the affected area would be as indicated by the lines of equal settlement in Fig. 1, and that the limits of settlement along the axis of the dam would be approximately 50 ft beyond the outside faces of Piers 1 and 5. This latter assumption was based on a study of the evidence in Fig. 1, on the carry-over effect on the augers as indicated during the pile driving, and on an examination of the original and final cross-sections.

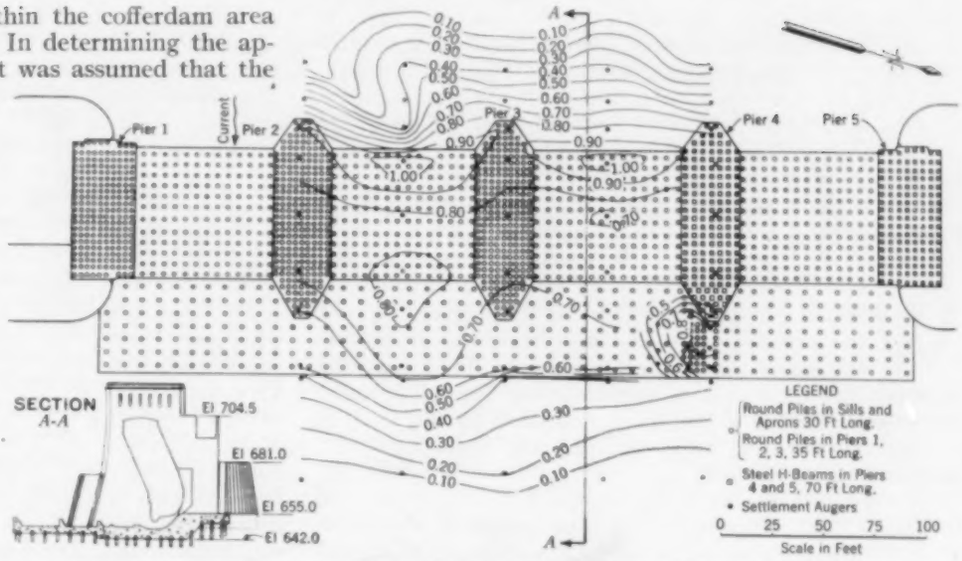


FIG. 1. GENERAL PLAN OF FOUNDATION, SHOWING LINES OF EQUAL SETTLEMENT OVER AREA SELECTED FOR OBSERVATION

The total area over which subsidence took place was thus found to be approximately 121,680 sq ft, whence the average settlement was 0.58 ft. This value compares with the 0.53-ft subsidence between the center lines of Piers 2 and 4, computed from the observations on the augers. Although these results are to some extent approximate, they are believed to reasonably indicate the effect of driving piles into an artificial sand foundation of this type.

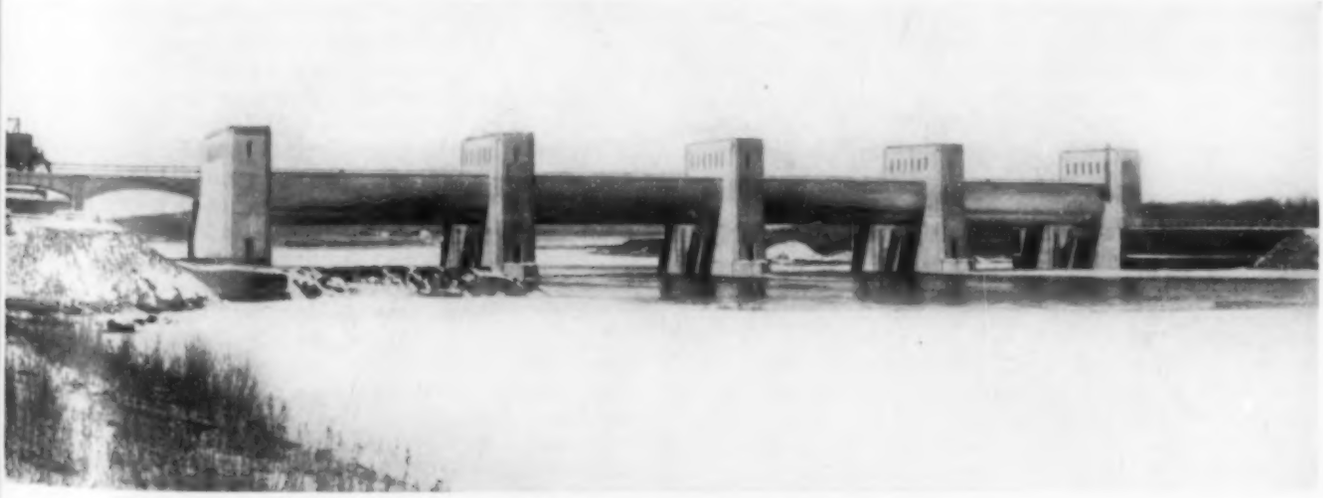
COMPUTING INCREASED DENSITY OF FOUNDATION SAND

Assuming that the increase in density of the foundation sand occurs entirely in the loosely placed backfill, and taking into account the displacement of material by the foundation piles, the average increase in density of the foundation sand can be approximated. For example, the average settlement within the limits of Pier 3 footing was 0.78 ft, and the total area of this footing is 2,241 sq ft. This represents a loss of 65 cu yd of material. In addition, there were driven in this area 235 round timber piles which displaced approximately 130 cu yd of material above El. 624.0, the lower limit of the foundation backfill. The total decrease in volume of sand above El 624.0 in the footing of Pier 3 was therefore 195 cu yd, which indicates that the average unit weight of the soil above El. 624.0 had been increased approximately 12 per cent.

By this same method, the approximate increase in the average unit weight of the foundation soil was found to be 4.7 per cent below Pier 4, where steel bearing piles were driven at 4-ft spacing; 7 per cent below the sills, where round timber piles were driven at 6 and 8-ft spacing; and 12 per cent below all piers where round timber piles were driven at 3-ft spacing.

These values may be in error to the extent of not considering the displacement of material outside the limits of the various areas, and also on account of the assumption that the lower limit of change in unit weight due to settlement is at El. 624.0. It should also be pointed out that the percentage of increase in unit weight is believed to be much greater at a point slightly below the subgrade elevation than it is near the lower limit of the loosely placed backfill. Despite these qualifications, however, the data indicate beyond a doubt that a loosely placed backfill will be compacted by pile driving, and it is hoped that they may prove of value in design studies of other foundations of a similar character.

Lock and Dam No. 3 was constructed under the direction of the St. Paul district of the Corps of Engineers, U. S. Army, of which Lt. Col. Philip B. Fleming is district engineer. W. D. Fairchild was resident engineer for the United States, and was assisted by the writer. W. W. Ralphe, assistant engineer, was in direct charge of the field work for the compaction studies, under the writer's supervision.



LOCK AND DAM NO. 3, MISSISSIPPI RIVER, AS SEEN FROM UPSTREAM

"On the Bottom!"

An Informal Narrative on Submarine Diving and Its Application to Deep-Water Construction

FROM AN ADDRESS BEFORE THE SACRAMENTO SECTION

By ARTHUR L. ELLIOTT

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AS casually as if he were ordering ham and eggs for breakfast, the diver speaks into his telephone, 250 ft beneath the surface. "On the bottom," he says, and starts out to inspect the foundation, or set dowel bars, or put in a dynamite charge. Probably none of the skilled trades employed on construction is more fascinating or less well understood than his. And probably none is more important. On many a big bridge, for example, the diver is the only man ever to set foot on the foundations. What kind of man is he? What is he up against? What can he reasonably be expected to accomplish? Mr. Elliott's informal—yet informative—article, touches all these points. It is based on his experience as engineer of submarine inspection on the pier foundations of the San Francisco–Oakland Bay Bridge.

WHEN a diver is called in on a construction job, the primary objective is to have him do his job efficiently, without any mishaps. To accomplish this objective, it is of great assistance for the employer to know just what a diver is up against when he tries to work under water, and what he can reasonably be expected to accomplish.

There is a widespread impression that the profession of diving (if it may be called a profession in the loose sense of the word) is full of romance and high adventure. Actually, to a majority of the men engaged in it, diving is merely a means of earning a living; and these divers go about their work with no greater sense of danger than that which lumberjacks or steel workers feel about their respective jobs. As a matter of fact, an understanding of the underlying causes of accidents makes one realize that narrow escapes are more a discredit than a mark of bravery. When a diver gets into trouble, it is almost always his own fault or the fault of some of his crew.

The diving suit used on construction work is known as the "flexible" suit. It is made of several layers of heavy canvas, vulcanized together with rubber cement to form a watertight yet flexible material. This suit is joined by a watertight joint to a collar onto which the helmet is screwed. To keep the diver in an upright position, shoes weighing about 15 lb or more apiece, and a weighted belt weighing 60 to 120 lb, are provided. To explain the equipment a little more fully and point out its limitations more clearly, let us assume that you are an experienced diver about to make a dive of 200 ft, and let us follow you through your preparations for the dive, watch you as you make your descent and move around on the bottom, and finally see how you come back up and "take your decompression."

DRESSING FOR THE DIVE

First of all, you will want some webbing or an elastic girdle of some sort around your stomach and groin to help protect you against the pressure. Then you will want a couple of suits of woolen underwear, a pair of woolen breeches, and a wool sweater and jacket. On your feet you will wear perhaps three pairs of wool socks, and a pair of light moccasins if you so choose. On your head you will wear a helmet similar to that worn by an aviator, with your telephone earphones built in. This sounds like a lot of clothes to work in, but almost anywhere in the United States the water is quite cold at a depth of 100 ft, and unless you are intending to do hard manual labor you will need plenty of protection.

With your warm clothes on, you come out to put on your diving suit. As it lies spread out on the deck where your tender has it ready for you, it resembles a large headless gingerbread man. Obviously not built for a close fit, any diving apparatus is at best clumsy and is certainly not designed for cutting any fancy capers. You sit down on the bench and, with the help of your tender, start to climb into the suit much as you would get into a pair of coveralls which were not open down the front. You get your feet into place and pull the suit up around your waist and then the tender brings you a basin of water and some soap. It's not that your hands must be clean for your work, but that they must be wet and soapy to slip through the small rubber cuffs that keep the water from leaking in around your wrists. You soap your hands and slip them through the cuffs, and the canvas portion of your suit is on.

Next comes the collar and breastplate—all in one piece. The breastplate extends well out onto your shoulders and down over your chest and back. The collar is only high enough to provide the threads onto which the helmet screws. The tender sets the breastplate over your head and starts pulling the edge of the suit up onto the studs spaced around the edge of the breastplate. Holes are provided in a rubber gasket around the neck of the suit to fit over the studs. Next onto the studs goes a metal strip, and then wing-nuts to clamp the suit tightly to the breastplate and make the joint watertight.

Then you sit down again and your tender puts on your shoes. They are of heavy brass, loaded with lead to weigh from 15 to 30 lb, depending upon your preference. They look somewhat like Dutch wooden shoes and are held on by straps over the instep and up from the heel.

Now you have on just about all the gear that you can move around with, so you get over onto the descending ladder before you put on the rest of your equipment. You stand three or four rungs down the ladder while your tender hangs your belt, made of lead bars strung on a broad leather strap, over your shoulders. It has cross-straps front and back to hold it in place, and weighs from 60 to 120 lb, depending on your preference and the type of work you are doing. At this point your lifeline (if you are using one) is fastened around under your armpits. If you care to, you may wear a pair of canvas gloves—not to keep your hands warm, but to keep from snagging them on wire or nails on the bottom.

You are now ready for your helmet. Your tender brings it over with the air-hose and telephone line attached. You plug your earphone cord into a socket in the helmet; then your tender sets the helmet over your head, gives it a quarter turn and puts in a locking pin in back. The air-hose comes into the helmet on the top toward the back, and the telephone connection is just below. Near the base of the helmet, in back, is the exhaust valve by which you can regulate the amount of air that escapes. In front and on each side of the helmet are small round windows of thick glass, barred on the outside for protection. Thus from the inside, your range of vision is limited to three small circular holes—one straight ahead and one opposite each ear. Just above the front

window on the inside is the microphone which picks up your conversation and carries it "topside." The incoming air is brought around the inside of the helmet and released just above or just below the front window, thus assuring as far as possible that you will breathe the fresh incoming air rather than the stale air in the helmet.

Your tender brings the air hose around in front of you and lashes it so that the valve controlling the incoming air is conveniently located on your chest. The compressor has been running for some time and has built up the pressure in the reserve tank so that you have probably 125 lb per sq in. at your disposal. You regulate the incoming air and the exhaust valve so that you get enough air and yet your suit is not blown up like a balloon. By now the man on the telephone is asking you if you can hear him. You answer him "All right," and he returns an "O.K." for your voice. Your tender taps your helmet, signaling that all is ready, and you back down the ladder into the water.

THE BEGINNING OF THE DESCENT

As the water comes up around your helmet, you float away from the ladder and the tender pulls you over to your descending line—a light line secured on the bottom at the location of your work. With the top of your helmet just awash, you check your telephone again and see if your suit has sprung any leaks. All being satisfactory, you wrap your arms and legs around the descending line, reduce the incoming air so that your suit deflates somewhat, and slide down as fast as you care to—perhaps taking one or two minutes to go down 200 ft. The deeper you get, the more air you turn on to equalize the increasing pressure, endeavoring to keep the upper part of your suit inflated down to about your belt so that the water does not press against your lungs. Your ears "pop" frequently and you find it necessary to swallow and snort to keep the air passages in your head open.

It might be well to mention that the purpose of the descending line is to keep the diver headed toward the bottom as well as to bring him to the exact spot on the bottom he wishes to reach. The suit, being partially filled with air, has a greatly reduced tendency to sink, and without the line to guide the diver toward the bottom, he might drift through the water at about the same level or, should he turn on a little too much air, bob to the surface.

During the early days of the sinking of the San Francisco–Oakland Bay Bridge caissons, one of the men from the main office came down to the dock and wanted to make a dive to see how it felt. He was rigged out in a diving suit and lowered over the side into comparatively shallow water. He had been told that he should turn on a little more air as he neared the bottom, to equalize the additional pressure, so as soon as his helmet dipped below the surface, he began to do so. Almost immediately he bobbed back up to the surface, floating face down, his suit blown up like a balloon. Nobody said a word and the tender kept paying out the hose, telling him all the time over the phone how much hose he had out. The embryo diver, in turn, was telling how good he felt and how little the depth was affecting him.

AT THE END OF THE JOB

William Reed, Submarine Inspector on the San Francisco–Oakland Bay Bridge, Receives Congratulations from Chief Engineer C. H. Purcell

Finally he had 200 ft of hose out and his suit was distended to the point where there might be some danger of its blowing up. He reported no bottom yet. The boys went out in a rowboat and gave him a slap with an oar, bringing the immediate response that he had been hit by a fish. They towed him into the boat and deflated him and a good laugh was had at the would-be diver's expense. There is some doubt, however, whether he was ever thoroughly convinced that he had not been down 200 ft.

But to get back to you, on your way to the bottom. In due time you arrive there and over the phone give the men on top the traditional "On the bottom." Your tender immediately stops paying out the hose, and until you say you are ready to come up he will try to keep your lines just slack, but not slack enough to allow any loose coils to form. Once on the bottom you try to get the most work done in the shortest time. If you are in 100 ft of water, you may spend several hours on the bottom. At 200 ft, you will probably do well not to spend more than 30 to 40 minutes there. In 250 ft of water you will find that 15 or 20 minutes is about the limit. These times of course vary with your physical condition.

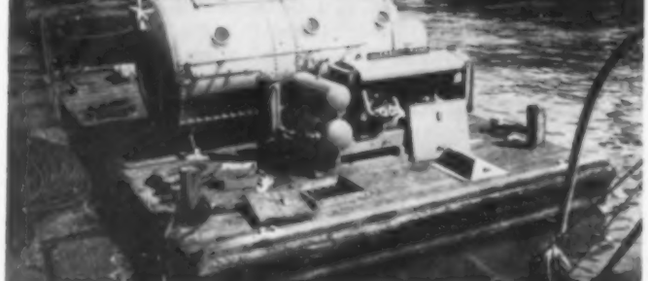
Breathing is rather difficult, and so is talking. Even when you swear that you are yelling at the top of your voice, the man at the other end of the phone will tell you that you are talking rather low and that you sound as though you had your mouth full of mush.

You adjust your air supply so that you are resting sufficiently heavy on the bottom to give your feet traction, and then go on about your work. Just what you may be down there to do we will discuss a little later. As you walk, you must lean far forward and drive your body through the water with your feet. If you are going some distance you may get there faster if you make yourself somewhat light and, lying horizontally in the water and kicking against some stationary object, drive yourself along like a fish. If you are in open water and the tide or the current is running, you will have to have several anchor lines to hold you in place.

When your job is completed—or when your tender has told you that your time on the bottom is nearly up—you come back to your descending line. You may be pulled up on your lines but it will be more convenient if there is a small staging available for you to stand on while being pulled up. Assuming that you have a little metal lattice staging, you stand upon it and turn on more air (so that your buoyancy supports both you and the staging) and tell your tender "Coming up." He brings you up part way and holds you there to start your decompression. If you have been down over 200 ft, this stopping point may be about 100 ft down, and you will probably stay there about 3 minutes if you have a recompression chamber up above, or much longer if you are going to take all of your decompression in the water.

In more or less warm and still water the lengthy process of decompressing in the water may not offer so much of an inconvenience. However, in open-sea diving there is serious hazard to a diver hanging on his lines from a boat in rough water to take his decompression. For the comfort and safety of the diver as well as the convenience

of his crew, his time in the water should be a minimum over that necessary to accomplish his work. Use of the recompression chamber reduces this extra time in the water to a bare few minutes. Coming up from a 200-ft dive to go into a recompression chamber, stops might be made for 3-minute periods each at 100, 75, 60, 45, and 30 ft. After this brief decompression period in the water the diver enters the recompression chamber and the air pressure inside is brought up to 50 lb per sq in. (equivalent to going down to about 120 ft again) and then reduced gradually over a period of two hours. During all this time spent in the chamber, the diver is warm and



THE FLOATING RECOMPRESSION CHAMBER MAKES IT POSSIBLE FOR A DIVER TO BE BROUGHT TO THE SURFACE QUICKLY AND "TAKE HIS DECOMPRESSION" IN SAFETY

dry, and easily accessible to his crew for help should he need it.

So little work has been done at depths of around 250 ft that a certain amount of experimentation is necessary to determine just what the best time and pressure for recompression may be. Recompression tables existing at the time construction was started on the San Francisco–Oakland Bay Bridge called for a recompression period of six hours, starting with a pressure of 80 lb per sq in. It was soon found that this was much too long a time, and that the pressure was so high that it had the same effect as staying too long on the bottom. In addition, several minutes were required to bring the pressure in the chamber up to 80 lb after the diver had entered. After some experimentation it was found that an initial pressure of 50 lb per sq in. and a time of two hours was very satisfactory. The pressure in the chamber could be brought up to 50 lb within half a minute after the diver had entered, thus cutting to a minimum the time interval between his leaving deep water and his returning to an equivalent pressure.

It might be interesting to note here that the success of experiments with a new type of diving dress to be used in an attempted salvage of the Lusitania is largely made possible by the elimination of nitrogen from the air the diver breathes, thus removing the main cause of the "bends." A mixture of helium and oxygen instead of the usual nitrogen and oxygen is provided for the diver to breathe. Experiment has shown that helium gets out of the system quite readily and that the time necessary for decompression is consequently quite short. It is claimed that experimental dives of 420 ft have been successfully made in still water.

Well, now that you see what is ahead of you, we will go back down to you standing on your little staging 100 ft below the surface of the water. You have been there for about 3 minutes, waving your arms and dancing a little jig to accelerate your circulation and thus assist the decompression process. Your 3 minutes being up, your tender says, "Time's up. Coming up to 75 ft." Whereupon he expects you to make yourself light so that he won't have to lift you.

This procedure continues until you have spent your time at the 30-ft depth, after which the tender says, "That's all. Coming up." Then you turn on the air and come shooting right to the surface. At the surface you pause a moment to see how you feel. Should trouble from the "bends" have already developed, it would be safer to go back down immediately until the pressure relieved the condition rather than to wait to get into the chamber. If you feel all right your tender pulls you over to the ladder and you awkwardly clamber up as fast as you can. He takes off your helmet, shoes, and belt, and into the recompression chamber you go.

Once inside, you take off the rest of your diving clothes and put on your street clothes. About that time, your tender will send in a plate of ham and eggs and a cup of coffee through the medicine locker. After eating, you will probably lie down on the cot and take a nap, and upon waking you will find that the pressure has dropped to atmospheric and you can open the door and walk out—your dive is over. If you were down 200 ft, one dive a day is plenty—or better yet, one every two days. If you were down only 100 ft or so, and were not down too long, maybe you will take another dip that afternoon. Usually one dive a day is the rule.

The recompression chamber, which makes diving so much faster and safer, may be made in a variety of styles and shapes. That used on the Bay Bridge was a model of efficiency and convenience. It was a sort of cylindrical boiler about 7 ft in diameter and 11 ft long, with one large main chamber and a small antechamber. In order to get the diver back under pressure as soon as possible, the air-tight door between the large and the small chambers was closed and the pressure in the large chamber was run up to about 80 lb per sq in. The diver then got into the small antechamber, closed the outer door, and opened a bleeder valve between the two chambers to equalize the pressure. In less than half a minute the pressure throughout was 50 lb and the diver could open the inner door and go in where his clothes and the cot were. The compressor is run all the time he is in the chamber so that the air is changed constantly while the pressure is being reduced.

WHAT THE DIVER MAY BE CALLED ON TO DO

Now we have seen the mechanics of diving. However, few of us as engineers will ever find it necessary to put on a diver's suit. We are more interested in just what sort of work a diver can do and how much can be expected of him. There are perhaps three very general classes of work to be done under water: (1) actual manual labor, the same as would have to be done if the water were not there; (2) inspection of work done by other divers or by machine equipment; and (3) searching for lost articles.

Almost any type of work may come under the heading of manual labor. Most common are jetting; laying and connecting pipe lines; making temporary repairs to ships' bottoms; freeing fouled propellors; jetting out corners and humps in caissons and cofferdams; sawing off piles; setting dynamite charges; plugging holes in sheet piling; and framing falsework.

Inspection is a broad field and an important one. Caissons for bridge piers nowadays are sunk so deep that in many cases the inspecting diver is the only man ever to set foot on the foundations. Open dredging-well caissons are used, with powerful jets and clamshell buckets to loosen up, clean off, and dig out the bottom. As yet no satisfactory method has been devised to inspect

the condition of the foundation from the top. The only solution at present is for an inspecting diver to go down and see how the foundation is.

In inspecting the work of other divers, the same points must be watched as on inspections "in the dry." In under-water work, however, there is an extraordinary opportunity for work that is careless and of poor quality. From the time the water closes over a diver's head until he comes up again, it is almost impossible to tell whether he is working or just sitting on the bottom putting in his time. In diving as in any other field, there are men who will pass lightly over their work or even completely neglect to do some part of it in the belief that their carelessness will never be detected. Then too, in complicated construction, owing to the handicap which the water, the pressure, and the lack of light imposes, some details may accidentally be omitted.

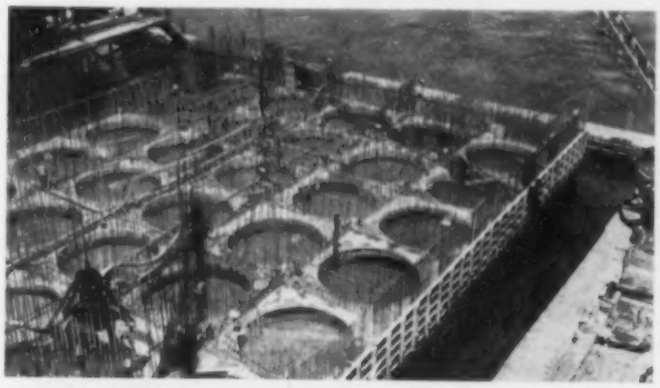
DIVERS WITH ENGINEERING EXPERIENCE NEEDED

There is therefore need for a man with experience in construction engineering as well as in diving, who will be well qualified to go down and look over work that has been done under water before it is finally accepted. Men qualified in both lines are rare. Most divers have had less than a high school education, and even a highly diversified assortment of jobs seldom provides them with the necessary construction experience.

Let us consider an every-day construction diving problem. Suppose you have a footing enclosed by sheet piling in 30 ft of water. You have put a gravel blanket in the bottom of the excavation after having driven the area full of piles. You want all the piles cut off about 5 ft from the bottom so that the butts will fit neatly into the concrete footing. It has been found impractical to unwater the area, so you send for a diver to do the work.

How long will it take him and about what will it cost? Diving is rather a free-lance occupation and there are as many prices as there are divers. The diver may furnish his gear and a tender for about $35 to $50 per day. If he is a citizen of doubtful ethics, he may come onto the job and talk it over with you and then, finding that you know practically nothing about diving, he may take advantage of this fact. He will go down the first day and along about noon the first pile butt will come bobbing to the surface—after that he will come up and eat a big lunch and tell you how hard he has been working. Men like that also put reinforcements on the seat of the pants of their suits. However, if he knows you understand what he should do and if he is a capable diver, he will probably see that a pile butt comes bobbing to the surface every hour or so. If you want to bet him $10 that he can't, he will probably get one sawed off in about 15 minutes. That is real exertion though, and he couldn't keep going all day at that speed if he wanted to.

Getting into larger construction and deeper water, suppose you have a deep-water open-dredging-well caisson similar to those used on the Bay Bridge, and you want the foundation inspected before you pour the seal concrete. You hire an able diver. What can you expect of him? The water may be 240 ft deep inside the caisson. The maximum time that he will be able to stay on the bottom in any one dive will be about 15 minutes. Every movement will be a great effort at that depth so he will not be able to cover much ground on a single trip to the bottom. You will have been digging and jetting just before he goes down, so he will have to feel his way around and make his investigation by feeling the bottom with his hands—no light would even begin to cut through the murky water. The caisson may be made up of 15-ft-square dredging wells, 4 wells wide by 7 wells long. You think that you have the caisson down to bedrock, so you clean out one corner and your diver goes down to see what is there. You get on his phone to hear what he has to say. You have previously talked over with him just where he is to go, and every time he changes his direction he tells you and you check him back. This time he is to go down in the corner, move along the side through two wells, then cut across the corner to the middle of the end



A CAISSON OF THE SAN FRANCISCO–OAKLAND BAY BRIDGE
Inside These 15-Ft Wells the Divers Descended—Sometimes as Far as 240 Ft—to Inspect the Foundations

and return to the starting point. He lands on the bottom and climbs up to the cutting edge. All clean—fine! He moves to his right along the cutting edge. Bang! You hear his helmit hit the cross-wall. That is a welcome sound because you know exactly where he is. He has to get down and crawl through a small opening under the cross-wall. You make a note to knock that ridge down. When he comes to the next cross-wall he tells you he is turning sharply to his right and cutting out across the corner of the caisson. A long silence then. If you ask him what he is doing, he will probably tell you in words of one syllable that he is walking—"what-do-you-suppose?" The extreme pressure affects different men differently but to all it gives a case of "nerves" in one form or another.

The next you hear from the bottom, your diver tells you he is climbing over a lot of loose stuff that will have to be cleaned out. That's fine, but where is he? You are supposed to know, mainly from past observation of how fast he gets around on the bottom. He is probably nearly over to the end wall of the caisson, but inasmuch as it takes about 2 minutes for his bubbles to get to the surface, they are still coming up over by the side wall. As a last resort you can have him stand still for two minutes and see just where his bubbles do come up, but in all likelihood he will take the whole two minutes telling you what he thinks of you for making him stand down there under that pressure just because you can't figure out where he is. Eventually he gets to the end of the caisson, and as his time is nearly up, he hurries back to the descending line and comes up. If he can't find the line, the tender pulls him up to the first stop and holds his line and the descending line together at the top, and in time they dangle together down below.

We have covered the mechanics of diving and a simple example of shallow and deep-water construction diving. Possibly some ideas have been gained of just what can be expected of a man working under water. In the last analysis work under water is much the same as work up above, except that it must be done by "feel" and is necessarily much slower. A man can do nearly anything under water that he can do out of it—except that, once in his helmet, he just can't scratch his nose.

Treated Wood Blocks Pave Streets in Tientsin

Open-Kettle Dipping in Asphalt Yields Product That Withstands Destructive Action of Heavy Steel-Tired Carts in British Area of Chinese City

By C. N. JOYNER

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TIENTSIN, the principal port of North China, is administered by a number of native and foreign municipalities. These municipal governments are faced by a variety of difficult problems, among which is the paving of roads to meet the demands of modern traffic and the excessively destructive wear and tear caused by native steel-tired carts.

The roads to be dealt with are between 25 and 30 ft wide. On them is concentrated very heavy traffic borne by a great variety of vehicles. Side by side may be seen the most modern American motor trucks and primitive springless, steel-tired native carts. These steel-tired carts cause the principal damage on all types of road surfaces in this area. They are familiar to everyone on the China coast. In the countryside they have very narrow tires, which often do not exceed $1^1/_2$ in. in width, and when new have a concave section which is most effective in cutting up any road, from the country mud tracks to the highest types of paving in the foreign settlements.

The municipalities maintained by the various nationalities on the coast have, in general, restrictive regulations requiring broader tires. A fair example of this is the requirement in the British Area in Tientsin that carts shall not have steel tires less than 4 in. in width. Other regulations favor the use of pneumatic tires or solid rubber tires by providing lower license fees for vehicles so equipped, and many of the larger Chinese cities, particularly on the coast, have arbitrarily insisted upon the use of rubber tires. In spite of these regulatory efforts, the damage done by steel-tired vehicles still governs the design of heavy roads in Tientsin and other ports on the China coast.

MANY TYPES OF PAVING TRIED

Prior to 1924 the principal roads in Tientsin were of water-bound macadam. Following that period, the more progressive municipalities (there are eight city governments in Tientsin) adopted asphaltic concrete for general use, and it has been entirely satisfactory where no large number of steel-tired vehicles use the roads. For the heavy-duty roads in the British Area, such as the roadway along the river front known as the Bund, experiments on types of roads have included asphaltic concrete of several grades, sheet asphalt, several sorts of vitrified paving blocks, reinforced asphaltic concrete, reinforced concrete, cast-iron blocks, and wood blocks.

The following sample of a traffic count for 24 hours made in the British Area in November 1934 gives an idea of the traffic these roads must withstand:

Steel-tired hand-drawn carts	6,662
Steel-tired animal-drawn carts	4,159
Rickshaws (pneumatic tires)	6,429
Bicycles	3,928
Automobiles	2,493
Motor trucks	1,776

Asphaltic concrete of all grades was and is successful on residential streets, but it failed on the Bund. The aggregate used is the only one available, a rather soft limestone, which may account for the extremely rapid deterioration of this type of pavement under the pounding of steel tires. This cause of failure, however, could not be used in explaining the destruction of the sheet-asphalt mixtures, which like the asphaltic mixtures were carefully designed and prepared in a modern plant under rigorous control.

Vitrified paving blocks, which in quality compare very favorably with the best grade on the American market, were given extensive trials, and their failure was undoubtedly due to the grinding action of the steel tires. Under this traffic the best type of vitrified block lost its armor in from 12 to 18 months and had to be replaced by the end of the second year.

Several patented paving materials were given a trial, among them an asphaltic concrete reinforced with mild steel mesh having from 4-in. to 6-in. openings, the traffic load bearing directly on the exposed vertical edges of the steel. This patented article has given very good wear, producing a smooth, evenly wearing roadway, but is not economically successful in

THE BUND, THE RIVER-FRONT ROADWAY OF THE BRITISH AREA IN TIENTSIN
Steel-Tired Carts Which Cause Heavy Damage to Road Appear in Foreground

Tientsin. The steel strips are very expensive, because they are imported from England, but the system deserves consideration whenever economic factors permit.

Reinforced concrete of standard proportions, and several concretes containing special hardeners as well as specially designed close-aggregate concretes, were all tried. Without exception, they were seriously damaged by the traffic in relatively short periods.

Cast-iron blocks, though noisy, produced an excellent road surface. When these blocks were laid in 1933 they cost about twice as much as wood blocks. Since that time, world conditions have produced an even wider spread in these prices.

Granite blocks, while not used on this particular roadway, have been tried at several points of excessive traffic concentration in other parts of Tientsin and have been found to be entirely too expensive, as there is no local supply. They do not last so well as the cast-iron blocks.

The common objections to the use of wood blocks are all valid in this district, but it was finally decided to attempt development of a wood-block treatment for local use which would eliminate some of the principal objections. In 1929 experimental stretches of wood blocks prepared by "open-kettle" dipping in asphalt gave results much more satisfactory, from all points of view, than any other type of pavement, and after a four-year trial the two heaviest traffic roads in the Area, amounting to approximately 22,000 sq yd, were laid with this material. These two roads, now at the end of their sixth summer, are in excellent condition and are requiring less than one-half of 1 per cent maintenance per year. The original trial sections, laid at selected intersections on the Bund in 1929, continue in excellent condition.

The climate of Tientsin for nine months of the year is excessively dry, but the other three months (in the middle of the summer) usually account for an average annual rainfall of 20 in. This moist summer season made it impracticable to use any of the pitch, creosote, or tar treatments for wood blocks—a fact that has led to abandonment of the use of wood blocks in many wet climates abroad.

The blocks for the Tientsin pavements were prepared from what is known on the China coast as Oregon pine. In other parts of the world it is known as Douglas fir, British Columbia pine, Columbia pine, and Puget Sound pine. The lumber actually used is from the Pseudotsuga Taxifolia. Standard blocks, 3 by 4 by 8 in., were originally dried on sand hot-baths, but the climate of Tientsin is so very dry for a large part of the year that this process was found to be unnecessary, and the blocks are now prepared by cutting from thoroughly dried and seasoned stock directly from the lumber yards.

TREATING AND LAYING THE BLOCKS

By the use of a metal mesh basket the blocks are dipped in asphalt at a temperature of 300–350 F, care being taken to keep within this range. The treatment is continued for a period of not less than one hour. The blocks are then withdrawn and drained on a screen above the boiler so that the surplus asphalt goes back into the tank. (No change in the penetration of the asphalt left in the boiler has been noted as a result of this procedure.) In spite of the fact that the asphalt does not penetrate far into the wood, the high temperature of the bath apparently drives off a certain amount of air and moisture from the blocks, and subsequent cooling forces the asphalt into the pores, producing a very effective sealing of the surface. One thousand blocks gain approximately 60 lb in weight by this treatment.

The asphalts used have varied in penetration from 45 to 55 deg, and are of the type normally used for sheet-asphalt or asphaltic-concrete mixtures. They are imported from Texas, California, Mesopotamia, and Venezuela, and are produced by various companies and by several processes. All have given satisfaction. It is possible that in more rigorous climates a higher-penetration bitumen, ranging up to 60 or 70 penetration, could be used successfully.

WOOD BLOCKS BEING PLACED IN ASPHALT MASTIC CUSHION, ON REINFORCED CONCRETE BASE

The blocks are laid in hot sheet-asphalt mastic $^1/_2$ in. thick on a standard reinforced-concrete foundation, care being taken to prevent any great variation in the depth of the mastic, which presupposes a fairly even concrete foundation. The mastic is mixed at a central depot wherever possible, but it has been hand-mixed in hot pans on the job where small quantities were required.

The use of sand for bedding the blocks was tried with some of the earlier paving and found to be entirely unsatisfactory. The sand collected moisture, which during warm weather caused the blocks to expand, displacing large sections.

In the original experimental area, blocks were hand-dipped on two sides with plain asphalt at the time of laying. It is found, however, that with the cheap labor available in this district it is possible to lay the blocks very much as a mason lays bricks in mortar, by applying hot mastic with a trowel at one end and one side of the block. The block is then rammed into place in the hot mastic base with a wooden mallet, and all surplus material is struck from the surface. The supervisors take great pains to see that the joints are thoroughly filled with mastic, and any small cavities are pointed up precisely as in laying ordinary masonry.

A system of transverse and longitudinal straight-edges and camber boards is used to secure an even surface. This requires constant supervision, as the native laborer does not enjoy the use of precise methods. The surface is rolled directly behind the workmen with seven-ton tandem rollers, and 45–55 penetration asphalt is squeegeed over the surface at a temperature of between 300 and 350 F. The surface binder is blinded at once as thinly as possible with limestone dust or fine sand, and the road can be opened for traffic immediately.

Maintenance during the first five seasons has consisted almost entirely of close inspection and the removal of occasional defective blocks. The blocks removed have been found to be defective because of coarseness of grain. Where the blocks have been carefully selected and are of a fine grain, wear has been negligible and very few blocks have failed. The squeegeed surface wears slowly and evenly and has not been renewed except in very small areas where traffic has been extremely heavy. This surface does not push or shove under steel tires as does sheet asphalt or asphaltic concrete.

Autobiography of George H. Pegram—Part II

At the Edgemoor Iron Company—the Pegram Truss—the Missouri Pacific Railroad

By THE LATE GEORGE H. PEGRAM

PAST-PRESIDENT AND HONORARY MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

THE January issue of "Civil Engineering" carried the first part of the autobiography of the late George H. Pegram, Past-President and Honorary Member of the Society, who died in 1937. The present installment covers Mr. Pegram's career as chief engineer of the Edgemoor Iron Company, his first years in New York City, the invention of the Pegram truss, and bridge building for the Missouri Pacific Railroad. Other installments will appear in future issues.

THE Edgemoor works were located on the Delaware River about four miles above Wilmington, the intervening territory consisting of marsh lands from which the name of the station, Edge Moor, is derived. The Edgemoor Iron Company was established by the Sellers brothers, engineers and makers of machine tools, whose products in that line were unmatched in this country. Mr. William Sellers was president. The brothers were doubtless induced to found the company for the use and development of their machines. The chief of their inventions used by the Edgemoor Company were the multiple punch, by which all holes were punched at one time as the plate moved along under the punches; the rotary planer, which faced the ends of long bridge members; and the "upsetting" method of making eye-bars. As a result, Edgemoor became the finest and largest bridge works in the world. The engineering and drafting departments were similarly superior and of such fame that promising graduates of engineering schools frequently applied for positions for the experience to be derived.

Edgemoor's first job was the iron work for the exhibition building for the World's Fair in Philadelphia in 1876. Orders for the Sixth Avenue Elevated Railroad in New York, the double-track bridge of the Pennsylvania Railroad across the Susquehanna River, and numerous other structures soon followed. When I arrived the contracts in the shops included a large market house for Demarara, South America, the Adelaide & Nairne viaducts and the Nowra Bridge in Australia, and all steel work except the cables for the Brooklyn Bridge. Besides bridges and buildings, the company also made boilers. The works ran day and night during the six years I was there.

LIFE AT EDGEMOOR

One can imagine the timidity with which I, who had never before been in an iron works and had only four months before become twenty-four years of age, approached the chair of chief engineer of the Edgemoor Iron Company! I asked to be placed in the drafting room as a draftsman without disclosing my real position until I had become familiar with the work.

My duties were to prepare designs for competitive bidding and execution, and to make the necessary shop drawings. I did not want the job because I did not feel that I could fill it, and my apparently independent spirit made the Sellers brothers more anxious to have me keep it permanently, and I was wined and dined and treated as one of the family. The secretary commented one day on my buying daily railroad tickets and suggested that I buy a commutation ticket. I replied that I might not be there long enough to use it up. He said, "Oh! you'll be here years." That was the first intimation that I was favored for permanence.

Wilmington was a great surprise to me. A city of about fifty thousand, it contained the largest bridge works in the world besides numerous other industries. The Philadelphia, Wilmington & Baltimore Railroad ran about half a mile to the west of the works. The workmen, for the most part, went to and from Wilmington in the workmen's train, while the white-collar employees walked or rode in the company bus to the station, Edge Moor, where trains were taken to town. Since we were located so far from any corner saloons, it was necessary for all but a favored few—who were served in the old farmhouse that served as the headquarters offices—to bring their lunches. The Sellers brothers and their staffs and the heads of the white-collar departments thus met each other in a social way and it was most enjoyable. It was certainly a great benefit to young men to thus know such men as William Sellers, the greatest machine designer of the time and a great character.

My office force contained men of many nationalities and various ages. Those from abroad were better educated—sometimes, I thought, over-educated. But it is interesting to note the success of those who started with no education. Outstanding among these was the late William H. Finley, the president of the Chicago and Northwestern Railway System. Finley's history is especially instructive. One day the superintendent of the shops asked me if I couldn't take a boy who was doing messenger service in the shops and who wanted to become a draftsman. I started him as a blueprint boy. He was rapidly promoted, and soon after I left Edgemoor, he went to the Chicago, Milwaukee and St. Paul Railway, where he did great work, becoming successively engineer of bridges, chief engineer, and president.

Of the educated engineers on my staff, J. E. Greiner became one of our great bridge engineers and is now head of the engineering firm of J. E. Greiner and Company, of Baltimore. H. B. Seaman became chief engineer of the Public Service Commission of New York, and the late Charles W. Bryan and O. E. Hovey, respectively chief engineer and assistant chief engineer of the American Bridge Company. Strangely enough in later years I was in intimate contact with all of them while chief engineer of the Interborough Rapid Transit Company.

One of the first structures I designed at Edgemoor was the bridge to carry Market Street, Wilmington, over the Brandywine. I mention this bridge only to show the perversity of fate. Soon after its erection I noticed a feature which I did not like, but consoled myself by thinking that the bridge would probably soon be replaced. However, when I last saw the bridge, fifty years after its erection, it was still in service.

I had always determined that when I was thirty I would change my course of life, whatever it might be. Accordingly, on December 29, 1885, I wrote my resignation and sent it in. I heard nothing from it but learned that Mr. Garrett, secretary and treasurer of the company, had called on my parents in New York to induce them to

stop such a wreck of my future. However, they would not interfere.

Accordingly, on May 1, 1886, I left Edgemoor, stopped a week in New York, and then sailed for Europe in the company of my friend, Alfred A. D. Ottewell, formerly a member of my staff at Edgemoor.

Back in New York in the late summer, I received a letter from Mr. Sellers asking me to come to Edgemoor to design a proposed elevated railroad for Philadelphia. Although they wished my stay to be permanent, that was not according to my plans. So when I completed my design, I left for New York where I opened an office.

MR. PEGRAM AND HIS STAFF AT THE EDGEMOOR IRON COMPANY
Top Row, Second from Right, William H. Finley, Later President of the Chicago and Northwestern; Center of Top Row, Andrew Morrison, Later Manager of the American Bridge Company Shops; Middle Row, Center, Mr. Pegram; Left of Mr. Pegram, Charles W. Bryan, Later Chief Engineer of the Edgemoor Iron Company and of the American Bridge Company; and Front Row, Left, John A. McNichol, Who Succeeded Mr. Pegram at Edgemoor

During this period I was trying to introduce the Pegram truss for bridges, which I had patented, and it was slow work. First I wrote a paper explaining methods of calculation of stresses, and similar features, and this was published in *Engineering News*.

The late Theodore Cooper, then dean of New York engineers, told me I would have greater success if I dropped that approach. This should have been apparent to me because a patent to engineers is like patent medicines to doctors. However, I persisted and in the spring of 1889 got a chance to bid as a contractor on a 200-ft span over the Verdigris River in Indian Territory for the Missouri Pacific Railway. I prepared the drawings, got a per pound price for the ironwork from Edgemoor, and then started for St. Louis to present my tender for the bridge. The structure was to be erected on falsework to be supplied by the railroad company.

The bridge engineer for the railroad, being a "practical" man without much technical training, threw my design out as an "experiment." So I took the matter up with S. H. H. Clark, president and general manager, who insured the award of the contract to me.

The trains had been running across the Verdigris River on a trestle, which also served as falsework upon which to erect the bridge. It was hoped that the structure would be finished before the high-water season, which was approaching when erection was begun. Drift piled up against the trestle as the water rose. By the time the steel work for the trusses and floor beams had been put in place, the pressure of the drift had become so great that the falsework was washed out. I saw the bottom chords bow out and expected to see the span drop into the river. But the drift freed itself, the span oscillated after it sprang back, and when it came to rest, the stringers and track floor were hurriedly placed and the bridge was ready for trains. I had made a profit of $1,500 on the job besides putting my truss in service.

THE PEGRAM TRUSS

I have been asked how I happened to invent the Pegram truss, and I will relate the circumstances, as it will illustrate how most inventions originate.

While I was at the Edgemoor Iron Company we received from Gen. William Sooysmith plans for a proposed bridge across the Missouri River at Glasgow, Mo., on which we were asked to give an estimate. The bridge truss shown on the plans had vertical posts and a curved upper chord. Considerable saving in weight resulted from the use of the curved chord, but the increased cost of the shop work, due to the unequal lengths of the chord sections and their different angles of abutment and the various lengths of posts, made the total cost of a span greater than that of the parallel chord truss, with vertical posts, which weighed considerably more.

It occurred to me that if both the top-chord sections of a curved chord truss and the posts could be made of equal lengths, the shop cost could be reduced to that of the straight-chord truss, which combined with the savings in weight due to the curved chord, would give it an economic advantage. To explain briefly:

In Fig. 1 the dotted lines represent the parallel chord truss of six panels having vertical posts. The full lines represent the Pegram truss, of greater length but of the same center height superimposed on the parallel-chord truss. Assume that all members are pin jointed and that the tension members, the diagonal ties, and the bottom chord are perfectly elastic, while the posts and top-chord sections are completely rigid and retain their lengths. If now the bottom chord AB is extended to $A'B'$, the dotted figure will take the form of the full-line figure or curved-chord truss with all top-chord sections and all posts respectively of equal lengths.

In practice I have used a circular arc for the top chord in order to get the same angle of bevel at the joints and greater depth at the middle of the truss, thus neglecting the equality of post lengths which is not important on account of their various cross-sections.

The largest bridge in which I used this truss was the combined railroad and highway bridge across the Arkansas River at Fort Smith, which was over half a mile long. The largest roof in which it was used was in the Union Station, St. Louis, built in 1893. The truss was also used in numerous bridges in Missouri, Kansas, Nebraska, Idaho, and Louisiana.

In June 1889 I was offered and accepted a position as consulting engineer with the Missouri Pacific Railroad. L. L. Buck, designer of the Williamsburg Bridge, took my New York office off my hands, and I went to live in St. Louis. I had been brought up in St. Louis, so it was natural to be there again. I had charge of new bridges and, under James W. Way, the chief engineer, of the construction of new lines. The Missouri Pacific System, which included the St. Louis, Iron Mountain & Southern and numerous other lines, covered about 7,500 miles, extending from St. Louis to Omaha on the north, to Pueblo, Colo., on the west, and to San Antonio, Tex., in the Southwest. There were also numerous branches.

The new lines constructed while I was with the road were from Coffeeville, Kans., to Fort Smith, Ark.; Kansas City to Fort Scott, Kans.; and Munroe to Alexandria, La. The Pegram truss was used in several replacements of bridges on the old lines and in all bridges on the new lines. The most important structures in

which it was used, in addition to the bridge at Fort Smith, Ark., were the Ouachita River Bridge near Columbia, La., and the Red River Bridge near Alexandria.

In 1890 I designed and built the Arkansas River Bridge, which consisted of thirteen 200-ft spans and a 350-ft draw span, all of Pegram trusses. The piers and abutments were of concrete capped with Bedford limestone. Bedrock was but a few feet below the water surface at the south bank, inclining to about 60 ft at the north bank. This required that all the piers be built by the pneumatic process, except the south river pier which could be built in open cofferdam.

MARMATON RIVER BRIDGE ON FORT SCOTT AND EASTERN RAILWAY
This Design Incorporates Pegram Truss of 200-Ft Span

I studied the hydrographs of the river for a period of several years and was impressed with the fact that there were always three minor floods in the late summer, which was the low-water season when the sand bar stretched almost across the whole river bed. I told the contractors that unless they built the south river pier quickly their cofferdam would be washed out. They glanced at the magnificent sandbar, smiled sweetly, and decided to let the status quo continue. Their cofferdam was washed out three times, the periods of flood permitting them to get it rebuilt in each case just in time for the next flood.

I had many interesting experiences while with the Missouri Pacific. Once while traveling by this railroad from Fort Smith to St. Louis, we arrived at Little Rock in the early evening to connect with the "Cannon Ball" for St. Louis. I stood on the rear platform to observe the roadbed, as it was my first trip over that line. (I usually used the St. Louis and San Francisco Railroad for my visits to Fort Smith, as it was the shortest route.) We entered Little Rock by a bridge over the Arkansas River located very near the railroad station. The bridge was a combination structure, the chords and posts being of wood and the tension members of iron. The railroad was carried on the lower deck, and a wagon highway on the upper. I examined the bridge as intently as I could while the train ran over it at slow speed toward the station. As I looked, I thought I discerned the irregular line of crushed timber in the top chord. The "Cannon Ball" was then ready to start, so as soon as our train stopped, I ran to the office and told the agent that I believed the bridge had failed and that he must not let the "Cannon Ball" leave until it had been examined. He said he would hold the train until I talked with their bridge engineer. The latter flouted the idea of the bridge having failed, saying that an excursion train, headed by two engines, had crossed it just before my train. We went to examine the bridge. The line I had seen did not impress him much as there were no splinters, but when I called attention to the deflection of the north rail he began to take notice. We went on the top, took up a plank of the roadway, and found that the chord had crushed, but he argued it was only one stick of the four comprising the chord. I suggested that we examine the ends of the other sticks which broke joint in different panels, and all were found crushed and splintered up—not down. The bridge was condemned, and all trains were routed via the Cotton Belt bridge about a half mile below, until new steel spans replaced the old.

On my arrival at St. Louis next day, President Clark sent for me to hear the details. He said seriously, "This is a most providential thing that has happened to me!"

DESIGNING THE ST. LOUIS TERMINAL

In 1891 the Terminal Association of St. Louis, formed of the seven railroads having their terminals in that city, decided to build a Union Station. Competitive plans were asked for on specifications prepared by Hubert Tausig, chief engineer. I was asked to submit a design, but explained that I was too poor to take the chance. However, the board of directors did not like any of the plans submitted, and a committee consisting of the chief engineers of the seven railroads was asked to formulate a plan. When the committee met, it asked me to prepare a plan.

My plans for the train shed called for a structure 700 ft long by 610 ft wide to cover 32 tracks. It was not practical to build it without intermediate supports, so I divided it into five spans. It seemed to me important to preserve the unity of the design, which had not been done in any of the designs submitted.

I designed the roof covering in the form of a circular arc. Along the crown of the arch a glass-covered skylight, 50 ft wide by 22 ft high, runs the length of the roof. This skylight is a backbone, as it were, for skylights 20 ft wide by 12 ft high, which extend down the sides of the roof at 20-ft intervals. The sides of the roof are alternate panels of glass and louvers, giving the appearance of ribs from a backbone. While the design was planned to distribute light and ventilation, it accentuated the arch form of the roof. At the sides where the roof was low, the columns were in the nature of vertical girders, which acted in conjunction with massive concrete foundations to carry the lateral force of wind on the roof to the ground, the intermediate columns being too long and slender to assist in this function. The width was divided into five spans of Pegram pin-connected trusses, the fish-bellied bottom chords of which gave the effect of being draped from the columns and thus did not detract from the appearance of the general arch form of the roof.

The building had a severe test in the great cyclone of 1896. It was in the center of the cyclone path; just 200 ft away, the wind drove a pine board through a $^{3}/_{8}$-in. steel-plate web. However, the train house suffered no damage—a fortunate circumstance as it proved a refuge for people running from the destruction around it.

FIG. 1. THE PEGRAM TRUSS

Rezoning Vicinity of World's Fair Site

A Review of the Regulations Adopted and the Principles Underlying Them

By CHARLES U. POWELL, M. AM. SOC. C.E.

ENGINEER IN CHARGE, TOPOGRAPHICAL BUREAU, BOROUGH OF QUEENS, LONG ISLAND CITY, N.Y.

THE decision to develop 1,200 acres in the Flushing Meadows as a park, and to locate the World's Fair there, required a complete rezoning of the area. It was obvious that the original "unrestricted" designation, adopted in 1916 when all New York City was zoned, could no longer apply. In December 1935 Mr. Powell was appointed as head of a committee to study the problem and formulate a solution. In the accompanying article he reviews the history of this rezoning project, and concludes with a discussion of principles applicable to zoning in general. His paper was on the program of the City Planning Division at the 1939 Annual Meeting.

NEW YORK became the pioneer city in zoning in 1916, when its entire area was zoned by a committee of which Edward M. Bassett, Assoc. M. Am. Soc. C.E., was chairman. At that time the section of Queens Borough now known as the World's Fair site—a vast marsh land that once formed the southerly part of Flushing Bay—was zoned as an industrial region.

In 1919 the city entered into a contract with the Brooklyn Ash Removal Company for the disposal of ashes gathered in Brooklyn. That company bought an immense tract of land, some 300 acres on the Flushing Meadows, which for years afterward was known as the Corona Dumps. Neighbors around fought against this dumping of ashes, in which there was 10 to 15 per cent of garbage and sometimes more, but the company continued its practice. Consequently noxious odors and rats abounded.

About 1934 the city bought the garbage incinerators owned by the Brooklyn Ash Removal Company and with them went the Corona Dumps, which were turned over to the Park Department for development. The department thereupon began to acquire additional land to square out the park. The purchase of the dump brought the Flushing Meadows Park a vast quantity of ashes, of which some 6,708,000 cu yd were available for grading the remainder of the area.

In 1935 it was proposed to hold a World's Fair to celebrate the 150th anniversary of the inauguration of George Washington and of the beginning of constitutional government in the United States. With the decision to have it in New York City came the problem as to where it should be located. Floyd Bennett Field in Brooklyn or the Pelham Bay Park in the Bronx would have been chosen had it not been for the city's ownership of the Flushing Meadows covered with spoil available for fill. So the Corona Dumps actually were responsible for the location of the World's Fair at Flushing Meadow Park and for the resulting expenditure of over $100,000,000 in that area for permanent improvements such as sewers, highways, bridges, and parks.

Just before the fair was proposed, a major system of parkways had been constructed through Queens Borough. This included Grand Central Parkway, extending from the city line at Nassau County to the south end of what is now the World's Fair site; Interboro Parkway, from that point west into Brooklyn; and the Grand Central Parkway Extension, skirting along the west edge of the area containing the Corona Dumps, and of Flushing Bay to the Triboro Bridge. The total length of this group of parkways, constructed with no grade crossings or red lights, is 18 miles.

To protect the esthetic charm of these broadly landscaped parkways and to prevent a detrimental type of property development in their vicinity then became an issue. Hence a stringent zoning of adjacent areas was inaugurated, and with the help of other city agencies the Topographical Bureau of Queens Borough began a rezoning study. The proposed changes in zoning were adopted by the Board of Estimate and Apportionment in 1934. In all, they affected 6,715 acres—an area nearly one-half as large as Manhattan Island.

Before Flushing Meadow Park was definitely chosen as the site for the World's Fair in October 1935, the Park Department, under Commissioner Robert Moses, anticipating this action, had completed a study of the marsh land and adopted a park plan for it. On this land the World's Fair Corporation laid out the Fair in a manner entirely consistent with the park plan, so that when the temporary Fair buildings are torn down, a great park of 1,200 acres will come into being.

Zoning that might have been proper if the Flushing Meadows had developed as originally proposed—that is, as a manufacturing center—would obviously be improper for the territory adjacent to a great city park. On December 1935, the chairman of the Queensboro World's Fair Committee appointed the writer as head of a committee to study the zoning problem and to formulate a solution. He was fortunate in securing as members of this committee Judge John M. Cragan, Harold M. Lewis, M. Am. Soc. C.E., George C. Meyer, and William T. Yale. All these men had had much experience in property development, and resided or operated in surrounding territories. The committee worked earnestly and effectively on the problem, and held many hearings at which the opinions of property owners in the areas were considered.

AERIAL VIEW OF THE WORLD'S FAIR SITE AND ENVIRONS, 1935; FLUSHING BAY IN BACKGROUND

The White Line Includes the Area of the Park at the Time of the Rezoning Study

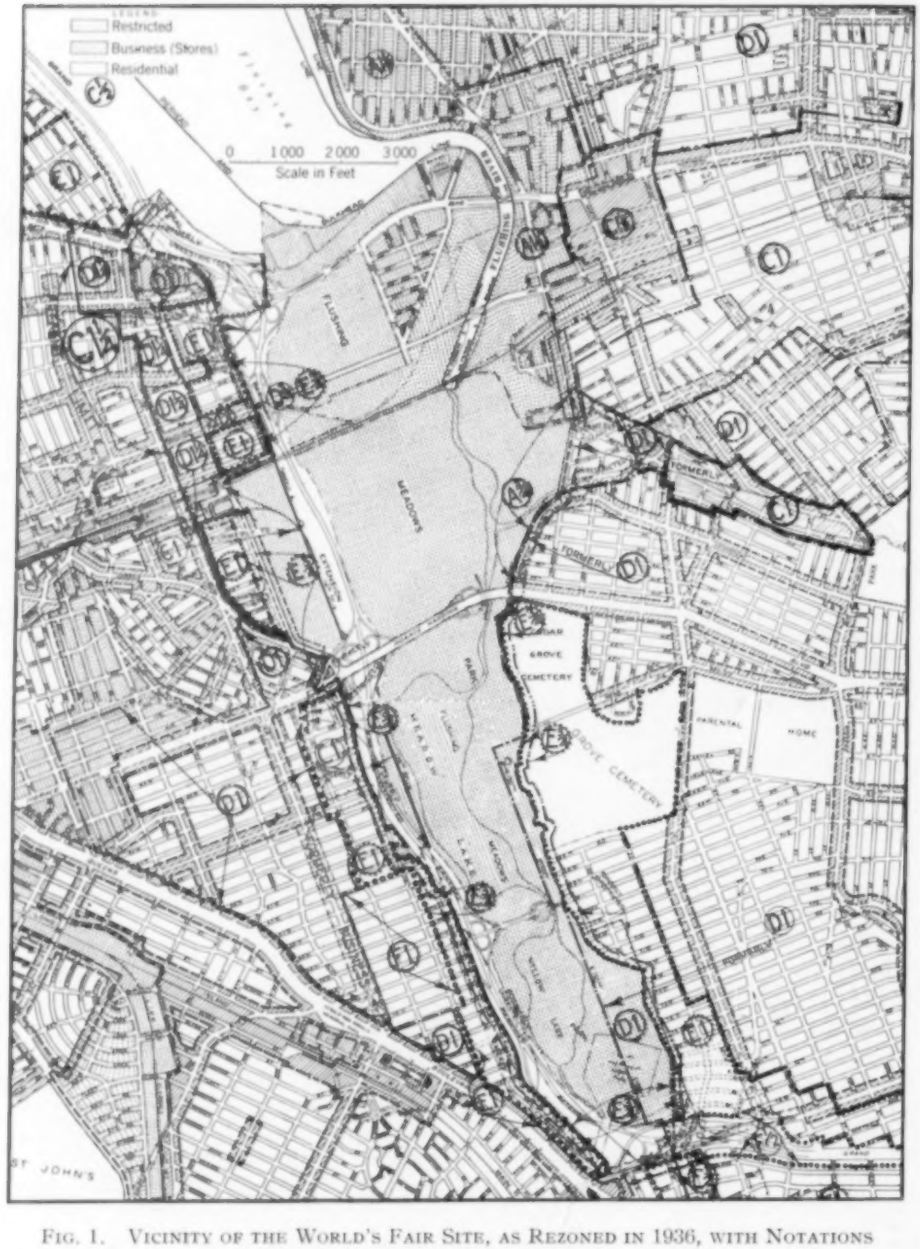


FIG. 1. VICINITY OF THE WORLD'S FAIR SITE, AS REZONED IN 1936, WITH NOTATIONS INDICATING THE OLD ZONING (FOR AN EXPLANATION OF THE SYMBOLS, SEE FIG. 2)

It must be emphasized that large sections surrounding this new park were already "protected" in considerable measure by existing zoning. Forest Hills and Kew Gardens, on the southwest, were already high-class residential districts. Corona, on the northwest, has both industrial and residential areas. So has that part of Flushing adjacent to the Fair area on the northeast.

In New York City, there are three forms of zoning restrictions or designations. The first, "use," is self-explanatory. Under this designation there are three classes in the area under discussion: residential, business (stores), and unrestricted (manufacturing of nearly any kind).

The second designation, "area," deals mainly with the percentage of coverage by buildings on a lot of a given size. In this designation there are now seven classes, but at the time the World's Fair was zoned there were only six—"A," "B," "C," "D," "E," and "F." The new designation is "G." The "A" area permits the greatest coverage and the "F," at that time the lowest, allows generally 35 to 40 per cent of the lot to be covered. Buidings in "F" zones must be set 15 ft back of the street line and must have a clear space of 5 ft on each side of the lot.

The third designation is "height," which depends primarily on the width of the street. It is indicated by figures—$\frac{1}{2}$, $\frac{3}{4}$, 1, and 2. For example, on a street 100 ft wide, where the height designation for the property is 2, a building can be built at the street line to a height of 200 ft. However, a short distance back from the building line, the structure can be extended to higher levels. This regulation is responsible for the building setbacks seen against the sky on Manhattan Island.

Problems before the World's Fair Zoning Committee were many and varied. For instance, what should be done along the main traffic arteries leading through the Fair site, such as Northern Boulevard, Roosevelt Avenue, and Horace Harding Boulevard? Ordinarily these would have been zoned either as "unrestricted," or for "business use." To avoid any depreciation in property values along these streets, we decided to zone them for "business use." This would keep out undesirable industries, yet would permit the owners to receive from rentals a sufficient income to justify the investments they had made in property.

By far the greater part of the territory surrounding Flushing Meadows and the future park, we decided, should be restricted so as to develop as the highest type of residential district. A general rule was accordingly formulated—that in the area within 100 ft immediately adjacent to the Fair site, an "F" or an "E" area designation should be established. In the "F" area, where the most highly desirable residences are usually constructed, the buildings could be erected to a height of about 75 ft, although it will be possible to attain a maximum height of about 100 ft by setbacks. Along the main thoroughfares, the property was given a business designation.

The most important objection from property owners that we met was to the "F" or "E" area designation. Several large owners of property objected to these designations believing they would prohibit the construction of profitable apartment houses. These particular owners had had no recent experience in apartment house construction, and it was necessary for us to convince them that the apartments being built throughout the borough were nearly all of a character to bring them under the "F" designation. This was true even in territory that permitted a much larger coverage, as in "D" and "C" districts. Owners had found it profitable to construct their apartments with considerably more garden space around them.

It was difficult at first to convince the objectors. One day we took some of them out to Flushing and showed them the apartments constructed as an outcome of the famous Fox Lane decision. Here the owner of a large plot at the corner of Bowne Avenue and Lincoln Street had endeavored to construct, in an area designated as "C," an apartment covering all of the plot that the zoning would allow. The neighbors had opposed this and had brought about a zone change designating the territory as "F." Before this action was taken by the Board of Estimate, the Fox Lane Corporation had obtained a building permit, and an architect had planned the building. This case was taken to the highest court in the state. It was decided that, unless a considerable amount of physical work had been done before the zoning change took effect, the building must conform to the new designation. So there was nothing for the company to do but redesign the building. However, this apparent misfortune proved a blessing, as Lincoln House became one of the most profitable apartments in Flushing and was always fully rented. When the objectors were made familiar with these facts, they became advocates of our proposal.

The plan for rezoning the area around the Fair site (Figs. 1 and 2) was presented, with the recommendation of the committee, to Borough President Harvey on January 17, 1936. He approved it and transmitted it to the Board of Estimate and Apportionment, which on May 1, 1936, adopted it without change. This was the largest single rezoning project to come before the Board for consideration since the original zoning resolution of 1916.

The effect of the plan will be to insure around Flushing Meadow Park a development of the highest possible residential character. It will, I think, stabilize values and give us finally one of the most orderly and beautiful residential sections in the entire Borough of Queens.

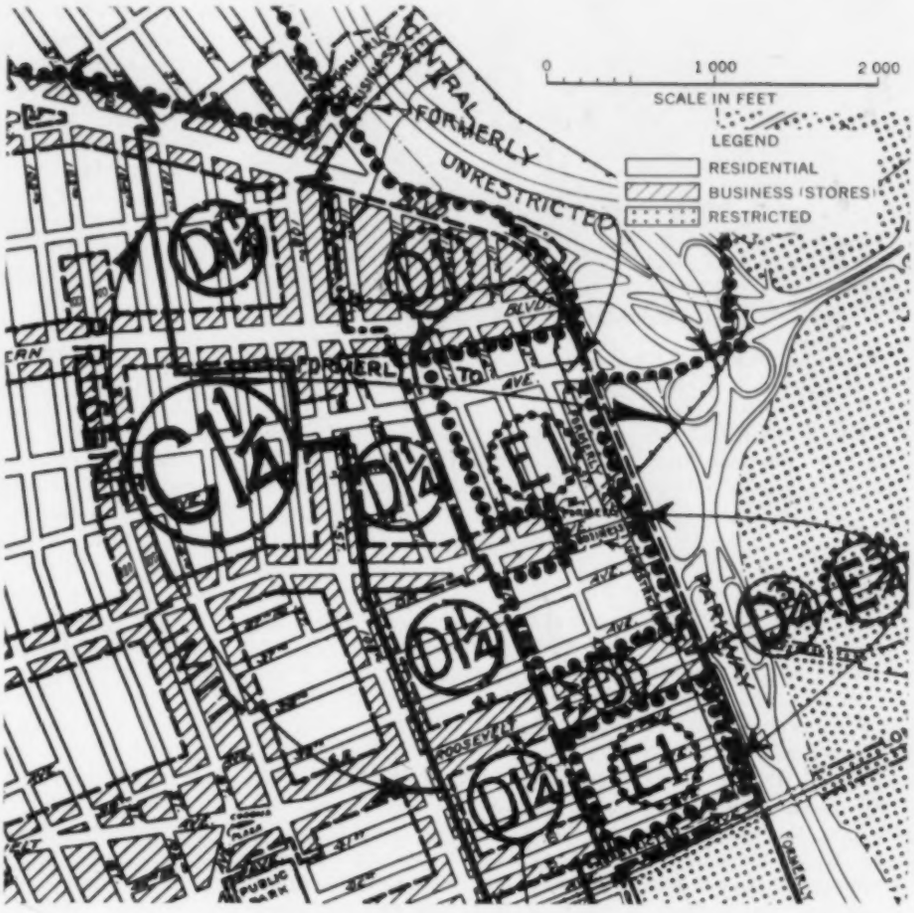
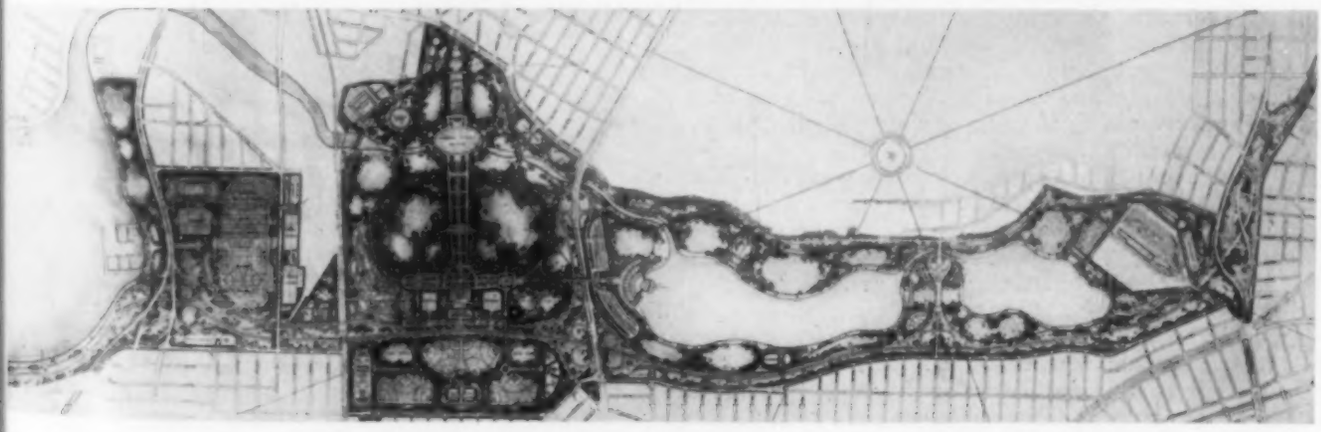


FIG. 2. ENLARGED DETAIL OF FIG. 1

The "Use" Designation Legend Is Shown on the Map. "Area" and "Height" Designations, Explained in the Text, Are Indicated by Letters and Numbers in Circles, the Type of Line Composing the Circle Being the Same as That of the Line Bounding the Area to Which It Applies. Old Zoning Designations and Limits Are Indicated by the Word "Formerly"

A legislative act permitting the City of New York to lease the lands of Flushing Meadow Park to the World's Fair Corporation contained a provision that the city Board of Estimate could by ordinance control signs, billboards, advertising devices, shows, exhibits, amusements, and parking cars in the area immediately surrounding the World's Fair. The act also authorized the prohibition of tourists' camps within one mile of the World's Fair district in Queens County except where this ban might be set aside by the Board of Estimate.



AFTER THE FAIR, FLUSHING MEADOW PARK WILL BE DEVELOPED IN ACCORDANCE WITH THE GENERAL PLAN SHOWN HERE

THERE IS LITTLE ESTHETIC CHARM IN APARTMENT HOUSES OF THE TYPE PERMITTED IN A CLASS "C" AREA

The Commissioner of Parks was delegated by the World's Fair Committee of the Board of Estimate to draw up an ordinance in accordance with the legislative act, and in May 1937 it was transmitted to the Board of Estimate. The resolution laid out the territory to be affected by the ordinance, a strip generally about a half mile deep all around the Fair. Of course, this ordinance is of a temporary nature, effective only during the Fair, and should not be confused with regular zoning. It was very unpopular, especially in the areas zoned as unrestricted, and was strenuously opposed before the Board, but nevertheless was adopted on September 27, 1937.

Previous to the presentation of this resolution, it was rumored that syndicates were attempting to obtain control of all advertising space outside the Fair itself but visible to Fair visitors. It was realized that the hills around the area are high enough that large advertising signs and displays set up on them not only would detract from the scenic effect of the Fair, but also might conflict with the Fair's night displays.

It is realized that this temporary ordinance is going to be difficult to enforce if legally opposed by the owners, especially in the unrestricted areas. The triangular area just east of the parking field and south of Northern Boulevard is a case in point. This area had been left "unrestricted" in the 1936 rezoning, but it fell within the limits affected by the 1937 ordinance. The Board of Standards and Appeals, I think, will without exception approve the application for the parking of cars there. The Board's action in this regard will presumably be governed by the anticipated results of court action.

FAIRNESS A BASIC PRINCIPLE OF ZONING

Now a word about zoning in general, with particular reference to the principles that governed the committee in its work. Riding rough shod over property owners, on somebody's theory that it might better mankind, never should be done; and if it were done it probably would not stand the test of the courts.

In the recent Linden Boulevard case in Brooklyn, Judge Lehman of the Court of Appeals cited the case of the Pennsylvania Coal Company v. Mahon (260 U. S. 393,415) as follows:

"In the prevailing opinion in that case Mr. Justice Holmes pointed out that 'the general rule at least is, that while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking.' Whether a regulation does go too far is a 'question of degree—and therefore cannot be disposed of by general propositions.'"

Justice Lehman further stated: "And here Mr. Justice Holmes gives warning that we are in danger of forgetting that a strong public desire to improve the public's condition is not enough to warrant achieving the desire by a shorter cut than the constitutional way of paying for the change." From these words of Mr. Justice Holmes, Judge Lehman concluded that "An ordinance which permanently so restricts the use of property that it cannot be used for any reasonable purpose goes, it is plain, beyond regulation, and must be recognized as a taking of the property.

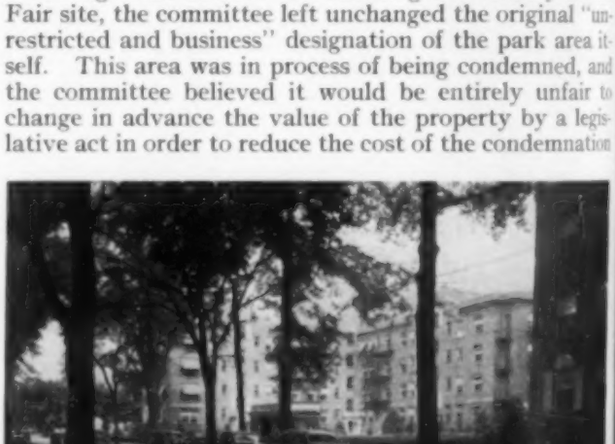
"Even so, it is conceded that prognostication that the district will in time become suited for residences rests upon hope and not upon certainty, and no estimate can be made of the time which must elapse before the hope becomes fact."

When zoning is carried too far it will fail, and in fact, result in the taking of property. The hope that a restriction will result in a profitable new use is insufficient to sustain a curtailment of property rights under the guise of zoning.

Further, the zoning of property of "Peter" for the sole reason of benefiting the property of "Paul" has not been found valid by the courts. The writer believes this will hold for public property as well as private. The proof should be not that the restriction will protect the public park, but that the park will make private land reasonably suited for the restricted use.

In general practice, zoning has been and will be guided by property values considered on a large scale, and without minor variations for the benefit of individual cases. Such cases should be taken care of by a board of appeals; without such a board, with power to grant exceptions where unnecessary hardships in zoning occur, all zoning would fail. Of course, an unrestricted lot in the middle of a residential section would be of great value to the owner. But it would damage other property in the neighborhood many, many times what this extra value might be. When, on the other hand, a neighborhood in general would be rendered more valuable through a new designation, it is probably proper to bring that designation about.

Zoning must be fair. In rezoning the vicinity of the Fair site, the committee left unchanged the original "unrestricted and business" designation of the park area itself. This area was in process of being condemned, and the committee believed it would be entirely unfair to change in advance the value of the property by a legislative act in order to reduce the cost of the condemnation



"LINCOLN HOUSE," A CLASS "F" AREA DEVELOPMENT, HAS DEMONSTRATED THE PROFITABLENESS OF LEAVING PLENTY OF GARDEN SPACE AROUND THE BUILDINGS

to the City of New York—that is, reduce the amounts the several owners would receive for their property.

In zoning one must always bear in mind that he is dealing with the property of others—often with the entire life savings of an individual. That the change is best for the greatest number is not sufficient excuse to ignore the rights of the small, or even the large, property owner.

Swimming-Pool Control

Careless, Unsanitary Operation Too Often Condoned by Public; Suggestions Made for Improvements in Operating Technique

By HERBERT L. WHITE, ASSOC. M. AM. SOC. C.E.

SANITARY ENGINEER, PHYSICAL PLANT DEPARTMENT, UNIVERSITY OF ILLINOIS, URBANA, ILL.

Death of T—— H———, 16, F———, high school sophomore, who drowned in a swimming pool here yesterday, was termed "accidental" today by a coroner's jury. Searchers found his body at the bottom of the pool.—*Newspaper clipping.*

THERE is food for thought in the word "searchers," which indicates that the water in the pool was so dirty that it was necessary to hunt for the body. If T— H— had been swimming in a properly equipped and operated artificial swimming pool, he probably would still be alive, for the life guard could have seen the boy on the bottom and rescued him before it was too late.

Many deaths have occurred under similar conditions, yet swimming pools are still permitted by their owners to be a menace to the public, even though they have sufficient equipment to keep the water in a safe sanitary condition. This situation is possible only because parents are not aware of the true condition of the pools, and depend upon the infrequent visits of public health officials to keep them safe.

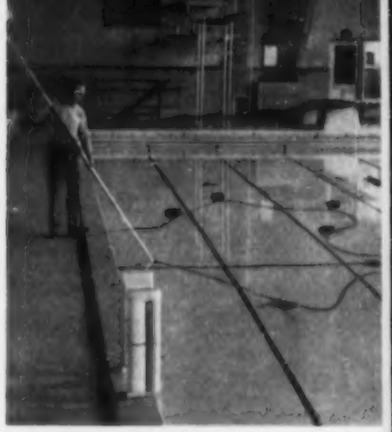
Whenever an organization, be it a park board, school board, or club, constructs a swimming pool for recreation or instruction, it seems that it should have and should feel a responsibility to maintain the pool in good condition. There should be no compromise. Either the pool should be operated so as to furnish reasonable protection to the bathers, or else it should be closed.

The excuse given for not maintaining a swimming pool properly is lack of finances. In many cases this excuse is absurd. For instance, at one recently completed pool, no expense was spared to provide adequate means for treating the water, but not one cent was available to obtain instruction for the janitor in the operation of the equipment, in the standards required for bathing places, and in the chemical tests needed. The only information he had came from the local plumber and various equipment salesmen, none of whom had ever operated a pool.

The water in most modern artificial pools can be maintained crystal clear and in good sanitary condition by means of a system whereby the water is continuously drawn off from one end of the pool, filtered, heated if necessary, sterilized with chlorine, and returned to the opposite end. This system is so efficient that after water has passed through the cycle several times, it is clearer and of more satisfactory quality than fresh water.

There is small wonder that swimming pools frequently become a source of infection and a likely place for accidents, because few operators have a clear conception of the problem. They should look upon the pool as a highly purified body of water, to which two things are happening: (1) dirt and germs are being added by bathers and blown in by the wind, and (2) dirt and germs are being removed by the filters, vacuum cleaner, and sterilizer. The only way to improve a cloudy water is to reduce the dirt being carried in—or increase the rate of dirt removal.

Usually the operator tries to find a magic compound the application of which will immediately make the water clear and sparkling, regardless of the condition of the pumps, filters, and sterilizers, or of the amount of dirt being carried into the pool. When the pool becomes cloudy, he starts dumping in more alum, which makes things worse. Then he decides there must be algae in the pool and he throws in some copper sulfate. The more material he puts in, the worse the pool becomes, and finally the water is just about as clean as dirty dish water. How much simpler it would be to refrain from throwing in more and more material, which places a greater load on the filters, and instead merely reduce the amount of dirt being carried in.



VACUUM-CLEANING THE BOTTOM OF A POOL

The Water in This Installation More Than Satisfies the Clearness Requirements for Drinking Water

The quantity of fine dirt brought in on the bodies of bathers is amazing. A pool in perfect condition can be spoiled in one afternoon by bathers who use it as a common bath tub—instead of as a source of healthful recreation. The same number of bathers would have little effect on the water if they would take a hot soap shower bath before entering the pool. It is interesting to note that while managements and bathers are concerned about using footbaths to prevent the much-publicized "athlete's foot," they do not seem aware of the more dangerous germs and filth carried in on the body in much larger quantities when hot soap showers are not required.

Within the last few years the importance of proper swimming pool control has increased owing to the large increase in the number of pools as the result of CWA, WPA, and PWA activities. These pools are controlled by local park boards, school boards, or clubs—which usually expect the janitor to operate the equipment with little if any real instruction in sanitation or water treatment. Yet the standards for turbidity are more strict for pool water than for drinking water, and the water in the pool should comply with bacteriological standards for drinking water. The operators do the best they known how, but the results are frequently poor.

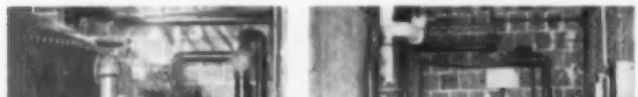
It certainly is not in the interest of public safety to permit a swimming pool to be opened to the public without a manager or operator entirely familiar with the American Public Health Association's standards for swimming pools. The first thought that occurs to prevent this is to enact legislation to license swimming pool operators. It seems as though most license schemes are devised, not solely for public good, but to keep the "ins" in and the "outs" out. However, some method should be devised to insure the maintenance of swimming pools in a safe sanitary condition. It is possible that public health departments could work out a correspondence course to be taken by prospective operators before pools can be opened to the public.

EXAMPLES OF INEFFICIENT OPERATION

A number of interesting examples of inefficient operation have been reported to the writer by various observers. At one pool, no attempt was made to test the water to learn whether enough chlorine was present to kill the germs, yet not so much as to hurt the eyes. Instead, the operator threw in some chloride of lime every day, and once a week, if the report of the weekly bacteriological analysis was unfavorable, he threw in a double

amount. Additional bacteriological analyses were not made after unfavorable reports. The filters were only one-fourth as large as they should have been, and the chemicals made the pool so cloudy that an object could not be seen a foot below the surface.

At another pool where in previous years there had been two deaths due in part if not entirely to the opaqueness



FILTER ROOM (LEFT) AND PUMP ROOM OF A WELL-EQUIPPED POOL
Around the Walls of the Pump Room, Left to Right, Are the Pool Heater, Circulating Pump, Chlorine Testing Outfit (on Table), and Chlorinator

of the water, no attempt was made to adopt a reasonable program to prevent the recurrence of such a calamity. Hot soap showers were not available; bathing suits were not laundered and sterilized; algae were permitted to grow; the chlorinator was run only part of the time; and reports of chlorine tests of the pool water were faked.

A third organization made little serious attempt to prepare to operate a new pool other than to fill it with water. After about a month's operation, the water was opaque; a pH comparator was being used to determine chlorine; no hot soap showers were being used; bathing suits were not controlled to insure cleanliness; copper sulfate was added to the water although no algae were present; pH bricks were added although none were needed; the attendant did not know how to backwash the filters properly; a cross connection existed between the swimming pool water and the drinking water; the chlorinator was run at the same rate for eight hours every day, regardless of the load imposed; the operation of the chlorinator, with its 100-lb cylinder of chlorine, was entrusted to an inexperienced man; and no gas mask was available to use in case of trouble. It would be a very serious matter if a leak or break should occur which would permit chlorine to trap the attendant and possibly many persons in the pool, locker, or shower rooms.

A fourth pool had cloudy water owing to the lack of hot soap showers, and the addition of large quantities of water containing iron. The operator wished a blue water and added copper sulfate frequently on the theory that it would produce the desired results. He did not know that a clear blue color is automatically obtained when the water is made clean and pure.

PERTINENT SUGGESTIONS FOR OPERATORS

Rather complete standards for both construction and operation have been prepared by the American Public Health Association in conjunction with the Conference of State Sanitary Engineers, and also by some of the individual states. However, these standards could be improved by adding a few operating suggestions to assist the men responsible for maintaining pool equipment. To partially supply this deficiency a few suggestions are given in the following paragraphs.

Color. Where the fresh water admitted to a pool is a dark grass green owing to the presence of a small amount of iron, the color can be changed to a beautiful light blue by simply overchlorinating until about 5 ppm of residual chlorine is present. Bathers cannot be in the water, of course, when the chlorine content is high. The water may be dechlorinated with sodium thiosulfate, or the chlorine content will drop unaided if a few days' time is available.

Algae. Algae can be controlled very satisfactorily by overchlorination. This has the advantage that the entire system—pipe lines, filters, and so forth—is sterilized. It has the disadvantage that the pool must be closed when the chlorine content is too high.

Chlorine. It seems to the writer to be a better policy when testing for free chlorine to use an o-tolidine solution containing excess acid as suggested by D. Tarvin, H. R. Todd, and A. M. Buswell ("The Determination of Free Chlorine," *Journal of the American Water Works Association*, Vol. 26, page 1662). This test will prevent any appreciable amount of false color if read at the end of 5 minutes, and using it will be more satisfactory than telling an operator what to do if he has a false color, because he may not know that he has it.

Fresh Water. Large quantities of fresh water added to the pool frequently increase the color and turbidity because the quality of the fresh water is not as good as that of the water in the pool. If the filter equipment and the operation of the pool are satisfactory, the health department will sometimes permit the drains from the overflow section to be connected to the recirculation system, so as to save water. This will make the addition of large quantities of fresh water unnecessary.

Turbidity. When the water unexpectedly becomes cloudy, it is just as important to check the amount of dirt being carried into the pool as it is to check the valves, the alum, and the filter sand.

Filters. All filter valves should be operated slowly to prevent upsetting the graded gravel. The sand strainers in the bottom of the filters frequently become clogged after a number of years, and the sand and gravel must be removed and the strainers cleaned.

Pool Cleaner. A vacuum cleaner or sediment remover used for cleaning the bottom of the pool should be designed with the nozzle about $\frac{1}{4}$ in. from the floor. This results in a more thorough cleaning and a saving in water.

Adjustment of Chlorine Content. If the chlorine content of the pool water must be increased without delay, this can be done by adding a clear solution of calcium hypochlorite. The chlorine content may be reduced with a solution of sodium thiosulfate.

"Elbowmeter." Many old installations had no method to determine the rate of filtration or recirculation. As long as the pump operated and a little ripple appeared near the water inlet, the operator was happy. For measuring the flow, W. M. Lansford, Assoc. M. Am. Soc. C.E., has suggested a simple U-tube or differential gage to indicate the difference in pressure between the inside and outside of a standard pipe elbow, or the pressure loss due to friction in a short length of pipe in the circulation line. Such a device will prove very useful because it tells when the circulation rate is retarded by clogged filters or some other obstruction.

In Illinois the State Department of Public Health is doing excellent work in raising the level of sanitation at swimming pools by inspecting and grading pools, and by conducting operators' conferences. Of course, progress is limited by the rate at which operators can absorb knowledge; in some cases progress is quite satisfactory and in others it is disappointingly slow. However, efforts of this type will do much to help solve the problem of poor swimming pool operation.

Fifth Annual Report of Special Committee on Hydraulic Research

As Prepared for the 1939 Annual Meeting of the Society

PREVIOUS reports of the activities of the Special Committee on Hydraulic Research have been published in CIVIL ENGINEERING for March 1937 (page 195) and March 1938 (pages 194–196). During 1938 the committee made further progress toward the objectives set up in these reports and initiated additional research. A meeting was held at the hydraulic laboratory of the U. S. Bureau of Reclamation, Denver, Colo., on July 15–16, 1938. All members and one cooperating member were present. Jacob E. Warnock, Assoc. M. Am. Soc. C.E., hydraulic research engineer, U. S. Bureau of Reclamation, was appointed to membership on the committee to represent the Bureau of Reclamation. Francis M. Dawson, M. Am. Soc. C.E., dean of the College of Engineering, State University of Iowa, Iowa City, was asked to serve as a cooperative member in connection with a new research project on the simultaneous flow of fluids and gases in pipes.

The committee also purchased a 128-frame motion picture camera that will be available in turn at all the research projects under way.

J. C. Stevens, M. Am. Soc. C.E., as chairman of the new Subcommittee No. 2 on Symbols for Hydraulics of the American Standards Association, reported that a committee of 16 members had been formed. Subcommittees are setting up tentative lists of symbols under four subheadings: general symbols, theoretical hydraulics, hydraulic structures, and hydraulic machinery. The first three have been completed. A list of symbols has been selected by the Hydraulic Research Committee itself for use in the proposed manual on hydraulic research.

The scarcity of published information on the comparison of performance of model with prototype was emphasized, and in several cases the committee has written letters directly to those in charge, urging publication of results. The committee has also taken steps to see that facilities for testing prototypes are included in the construction program.

FUNDAMENTAL RESEARCH PROJECTS

The committee wishes to acknowledge with gratitude grants of financial assistance made by the Engineering Foundation toward the support of the continuing "Fundamental Research Projects." Progress reports on these projects are presented in the following paragraphs:

Project 67-a. "Conversion of Kinetic to Potential Energy in Expanding Conduits," F. T. Mavis, M. Am. Soc. C.E., University of Iowa, Iowa City, Iowa. The tests of a transparent conical expansion $7\frac{1}{2}$ in. long connecting transparent pipes respectively 3 in. and 5 in. in diameter, have been completed, and tests of a sudden expansion are also substantially complete. Similar expansions of rectangular cross-section mounted between flat plates of transparent pyralin have also been constructed and tested, and these studies are being continued.

A mass of photographic and statistical data has been collected, and these data are now being analyzed. We are now attempting, by the analysis of 100 or more frames of motion picture film for each rate of flow, to determine at various points in the plane of the conduit axis the magnitude and direction of velocities and also the changes in those velocities (see Figs. 1 and 2). In this way we are attempting to make direct quantitative observations of the turbulence intensity at various points throughout the expanding conduit, and to put to a severe test the methods of measuring velocities in a conduit where the flow is undisturbed by direct insertion of instruments. This is a slow and tedious process, but it is one which seemed essential at this stage.

A. A. Kalinske, instructor in mechanics and hydraulics, has collaborated in the study, and during the year he has been assisted by E. R. Van Driest, Jun. Am. Soc. C.E., and A. R. Luecker, graduate students in hydraulics.

Project 67-b. "Traveling Waves on Steep Slopes," H. A. Thomas, M. Am. Soc. C.E., Carnegie Institute of Technology, Pittsburgh, Pa. During the past year work has been concentrated on a study of traveling waves and bores in a channel of trapezoidal cross-section. (During the two previous years the studies were confined to channels of rectangular cross-section.) A special steel channel was constructed, having a length of 92 ft and a trapezoidal cross-section with a base width of 0.5 ft and 45-deg side slopes. This channel was suspended from the roof trusses of the building by wire cables with counterweights, so that its slope could be easily adjusted to any value from 0 deg to about 8 deg. A new centrifugal pump, having a capacity of 1.75 cu ft per sec, was installed to deliver water to the upstream end of the channel, its discharge being measured by a venturi meter.

An adjustable inlet gate, opened and closed periodically by an electric motor, was placed at the channel inlet and served to create trains of traveling waves or bores.

A very desirable feature of this apparatus, in comparison with that previously used with rectangular channels, was the greater length of the channel. This feature was especially useful in studying the question whether the height of the waves would tend to increase or decrease as they traveled downstream.

The actual experimental work was carried on by John W. Daugherty, with the assistance of several undergraduate students paid from National Youth Administration funds. Mr. Daugherty worked on this project as his thesis in partial fulfilment of the requirements for the master's degree. Many experiments were run to determine the heights and velocities of traveling waves in this channel at various periods, discharges, and slopes, and the tendency of these to increase or diminish in height as they traveled downstream was studied extensively.

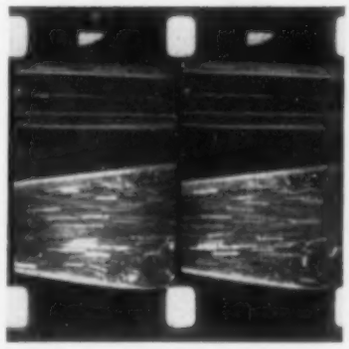


FIG. 1. TYPICAL MOTION PICTURE FRAMES FROM WHICH MAGNITUDE AND DIRECTION OF VELOCITY AT A POINT WAS DETERMINED AS A FUNCTION OF TIME

Numerous photographs of the waves were taken, many from a position vertically over the channel. The 45-deg slope of the channel sides made it possible to determine the profiles of these waves directly from the surface width of the water in the photographs, thus obviating the necessity of constructing glass observation windows in the channel sides.

The experimental results and their

analysis are given in Mr. Daugherty's thesis, which is on file in the library of the Carnegie Institute of Technology and with the secretary of the committee.

Project 67-c. "Phenomena of Intersecting Streams," M. P. O'Brien, M. Am. Soc. C.E., University of California, Berkeley, Calif. The work on open channel intersection has been suspended for the present and attention is being directed to intersections of closed conduits. There were so many variables in the open channels that it was thought better results would be secured by studying closed channel intersections first.

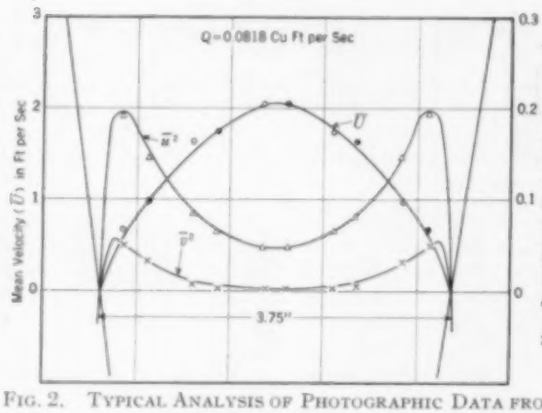


FIG. 2. TYPICAL ANALYSIS OF PHOTOGRAPHIC DATA FROM EXPANDING CONDUIT
Curves $\bar{u}^2$ and $\bar{v}^2$ Are Respectively Mean Square Deviations of Velocity at a Point in the Section Measured Parallel to and Normal to Axis of Tube

During the past year, flow in open flumes intersecting at various angles was extensively studied, and two theses and one special report were prepared and are on file with the committee. The principal result secured was to point to the necessity of a study of closed conduit intersections before continuing with those of open conduits.

Project 67-d. "Curves in Open Channels," C. A. Mockmore, M. Am. Soc. C.E., Oregon State College, Corvallis, Ore. Considerable data have been taken on velocity measurements at various sections of the bend of a rectangular section 18 in. wide and of varying depths up to 10 in. These data have been plotted into curves showing the conditions of flow.

A mathematical analysis, based on observed conditions of flow at a section half way around a 180-deg bend, has been made. Relative values of the acceleration and angular velocity at various points in the section were computed and plotted for comparison.

An auxiliary bend 4 by 4 in. in section, and similar to the larger channel, has been constructed and tests are being made in an attempt to evaluate the effect of the bend on the backwater curve. Curves of different radii will be included in the test.

The motion picture camera purchased by the Special Committee has been in use on this project. Globules of a mixture of xylol, n. Butyl Phithalate, and a dye, having the specific gravity of the water, are being used to define the velocities on the film in both direction and magnitude in various parts of the section as the water flows around the bend.

Project 67-e. "Sedimentation at the Confluence of Rivers," L. G. Straub, M. Am. Soc. C.E., University of Minnesota, Minneapolis, Minn. The principal objects of this investigation are to determine:

1. The geometrical shape assumed by the bed at the confluence with particular reference to sand bars and local disturbances, and their variance as the controlling conditions were altered;
2. The distribution and sorting of grain particles in the bed sediment, whether according to some definite plan of uniform gradation or merely as a heterogeneous grouping for each run;
3. The nature of the surface and subsurface currents at the confluence; and
4. The possibility of determining the tractive force and sediment characteristics for a given sand in the approach and discharge channels.

In past years studies have been confined to an experimental flume measuring 60 ft long, 2 ft deep, and 1 ft wide with a branch channel 18 ft long and of the same cross-section as the main channel. The data collected in the performance of these experiments may be classified in the following groupings: (1) study of tractive force and equilibrium slopes for various rates of sand transportation; (2) contour records at the confluence for each series of observations; (3) mechanical analyses of bed sediment; (4) records of current patterns at the current confluence.

The experiments thus far have been quite broad and sweeping in an effort to realize the focal points of interest and to determine specific methods of attack. Based upon the studies made during the past year, a new piece of apparatus has been designed so as to eliminate some of the shortcomings of the original experimental set-up. The new apparatus is situated in the recently completed St. Anthony Falls Hydraulic Laboratory, where water will be diverted through the apparatus direct from the river. The main channel in the new set-up is 3 ft wide.

NEW PROJECTS

Project 67-f and g. "Air Resistance to Flow of Water in Open Channels," L. G. Straub, University of Minnesota, Minneapolis, Minn. "Simultaneous Flow of Liquids and Gases in Pipes," Francis M. Dawson, M. Am. Soc. C.E., dean of College of Engineering, University of Iowa, Iowa City, Iowa. U. S. Bureau of Reclamation, Denver, Colo. Jacob E. Warnock, hydraulic research engineer.

This is a three-way attack upon the problem of flow of water in steep open and closed channels, together with its associated phenomena of entrained air. Studies will be made on field structures by the U. S. Bureau of Reclamation, on open channels at the University of Minnesota, and in closed channels at the University of Iowa. As the data become available, they will be freely interchanged and studied.

MANUAL OF HYDRAULIC LABORATORY PRACTICE: ABSTRACTS OF TRANSLATIONS

The first draft of the proposed manual, 102 pages, was completed, and was discussed at the annual meeting of the committee. It was decided to add a discussion of "Limitation of Models" to the section on "Distortion of Models." All members of the committee have reviewed the draft. Dr. Straub, who is acting as editor, assisted by C. E. Bardsley, M. Am. Soc. C.E., is preparing the final draft for mimeographing. The next draft is to be mimeographed and sent to interested persons for comment.

A second series of abridged translations of worthy foreign articles on hydraulics was authorized. E. F. Wilsey, Assoc. M. Am. Soc. C.E., of the U. S. Bureau of Reclamation, had studied and indexed a number of worthy articles. Starting from this list, together with suggestions received from 25 interested persons, the committee selected 10 papers for abstracting and publishing under the immediate supervision of D. P. Barnes, Assoc. M. Am. Soc. C.E.

Respectfully submitted,

SPECIAL COMMITTEE ON HYDRAULIC RESEARCH
J. C. STEVENS, *Chairman;* CHILTON A. WRIGHT, *Sec'y*

CIVIL ENGINEERS' SALARIES

Grading Plan and Compensation Schedule for Civil Engineering Positions—First Three Professional Grades

A Report of the Committee on Salaries, Presented to the Board of Direction, American Society of Civil Engineers, January 1939

Grading Plan for the First Three Professional Grades

FOREWORD

The first three grades above the sub-professional level are numbered from the lowest to the highest and each is described by means of a grade definition. The scope, and the upper and lower limits, of each grade are to be determined according to the grade definition.

Each grade definition is written in terms of the duties characteristic of positions properly to be allocated to the grade and of the qualifications consequently deemed necessary in a person fitted to enter upon the performance of the duties of such positions. Each grade definition is supported and clarified by examples of duties of positions properly to be allocated to the grade.

In interpreting these definitions, reference should first be had to the last section of this report for definitions of terms used in special or technical senses.

Grade I—Grade Definition

A. *Grade I Described in Terms of the General Nature of the Characteristic Duties:* Grade I includes all positions the duties of which involve civil engineering work of least professional difficulty and responsibility, as such work is defined herein.

B. *Grade I Described in Terms of the Minimum Requisite Qualifications:* The positions of Grade I are further described with respect to the minimum qualifications requisite for the satisfactory performance of the duties characteristic of them, as follows:

(1) *As to general education and experience:* (*a*) Graduation with a degree in civil engineering from an engineering school on the accredited list of the Engineers' Council for Professional Development, or (*b*) completion of the twelfth school grade, additional self-improvement through study of technical engineering subjects, and three years of experience on engineering work, or (*c*) any equivalent combination of education and experience.

(2) *As to general knowledge and skill:* Good working knowledge of mathematics through calculus, of the properties of materials used in construction, of engineering specifications, and of the customs and practices followed in expressing engineering decisions in drawings; and skill and dexterity in the use of such knowledge.

(3) *As to specialized qualifications:* Special courses, or outside study, in engineering subjects germane to the specific work, or experience on work in the sphere of specialization, and knowledge and skill in the subject matters and techniques involved in such work commensurate with the general knowledge and skill requisite for the grade.

C. *Grade I Described by Examples of Characteristic Duties Classified by "Processes":* The following illustrative combinations of duties, grouped according to several of the more common engineering "processes," and applicable to any field of practice and type of organization, are typical of positions properly allocated to the grade:

(1) *In surveying processes:* Under higher technical direction, but with some latitude for independent action and judgment under approved policies and standards:

Individually, or with one or two assistants, making observations and gathering and recording data for engineering reports and other technical uses; establishing lines and grades; and doing other field engineering work involving the use of transits, levels, and other surveying instruments, with responsibility for the technical soundness of the methods used and the accuracy and reliability of the observations and results.

Having charge of a small survey party on location, topographic, hydrographic triangulation, and other property or control surveys, or any of them, not involving especially complex or otherwise difficult problems, and of computations and calculations in connection therewith; with the aid of the party, determining, marking, and recording elevations, lines, grades, contours, and limits of properties; laying out angles and curves; platting profiles and taking cross-sections; establishing, recording, and indexing systems of bench marks, other monuments, and levels; securing and recording data as to conditions of ground soil and other facts bearing on designs and estimates; searching, verifying, and interpreting old survey notes; personally exercising immediate responsibility for the accomplishment of work by the party, for the technical soundness and compliance with prescribed standards of the methods used, and for

THIS report is the result of more than two years of intensive study on the part of the Society's Committee on Salaries. It covers the first three professional grades of civil engineering positions—a range which it is believed includes upwards of three-fourths of all graduated civil engineers—and is designed to apply equally to men in federal, state or municipal, and private employ. The Board of Direction now places it before the profession for appraisal, and informed, constructive discussion is invited.

The Committee on Salaries consists of E. P. Goodrich (chairman), A. B. McDaniel, E. O. Griffenhagen, Arthur Richards, and J. E. Root.

the accuracy and reliability of the results; personally planning, assigning, and supervising the work of the party, and participating in such work, principally by performing the more difficult and responsible tasks such as those of operating instruments, recording and platting field notes, and preparing reports.

Serving as assistant chief of a large survey party on simple or routine surveys, or a small one on complex or otherwise difficult surveys; as such, participating in the work of the party by operating instruments and carrying out other assigned details, principally involving the more difficult and responsible phases of the work, as by assisting in the planning, assigning, and supervising of the work, and by substituting for the chief of the party in his absence.

(2) *In designing and drafting processes:* Under higher technical direction but with some latitude for independent action and judgment under approved policies and standards:

Individually laying out and preparing detailed plans and estimates for minor construction projects, or for important parts of major construction projects of which the principal features of design have been established by higher authority; doing difficult work in drafting, computing, or estimating, calling for originality and judgment in meeting specific problems; making compilations of engineering statistics calling for complete understanding of the subject matter; preparing maps, graphs, charts, and diagrams, involving the compilation, interpretation, and representation of data for engineering purposes.

Serving as leader of a small group engaged on the application of standardized, routine methods to problems of computation and design and to the preparation or checking of detailed plans and estimates, or of a larger group so engaged on still more routinized procedures; assigning work, giving instructions as to methods, checking and approving work done, and seeing that the work is done on time.

(3) *In construction processes:* Under higher technical direction, but with some latitude for independent action and judgment under approved policies and standards:

With not more than one or two sub-professional assistants, serving as project engineer on a minor construction project, with responsibility for compliance by contractors with plans, specifications, and good workmanship, where the work is of standardized and repetitious character, or otherwise does not call for difficult decisions; interpreting the plans; staking out the work; inspecting the construction in progress; making field tests of concrete aggregates; taking samples of materials for laboratory testing; rejecting unsatisfactory work and materials; and preparing periodic reports, progress estimates, and final reports.

Serving as first assistant to the project engineer on a larger or more complex project; taking part in the several operations, particularly those of more difficult and responsible character; and taking the place of the project engineer in his absence.

(4) *In general:* Doing work of equal difficulty and responsibility involving two or more of the aforementioned engineering processes, or other civil engineering processes, with or without other engineering work of like grade, or work of sub-professional, or of clerical or other non-engineering, character.

D. *Grade I Described by Examples of Characteristic Duties Classified by "Fields of Practice":* The following illustrative combinations of duties grouped according to several of the more important "fields of practice," and applicable to any classes of engineering processes and any types of engineering organization are typical of positions properly allocated to the grade:

(1) *In structural engineering:* Performing such duties as are described in the preceding examples classified by engineering processes, primarily with respect to the use of materials of construction of known strength for meeting calculated stresses in bridges, buildings, and other structures of steel, concrete, or wood, as by:

Developing or checking complete plans and estimates for simple structures such as culverts, floor slabs, small plate girders, and the like, or preparing detailed plans according to prescribed designs for certain parts or elements of important or complex structures such as members of truss bridges, columns in steel buildings, floor beams, and the like.

Serving as project engineer in charge of a minor project involving structural problems or as assistant project engineer on such a major project.

Doing work of equal difficulty and responsibility involving two or more of such classes of processes, or other civil engineering processes, with or without other engineering work of like grade or of sub-professional, or of clerical or other non-engineering, character.

(2) *In hydraulic engineering:* Performing such duties as are described in the preceding examples classified by engineering processes, primarily with respect to the application of the laws of hydrostatics, hydraulics, and hydrodynamics, to the solution of engineering problems in connection with water supply, irrigation and drainage, water power, water transportation, and flood control, or any of them, as by:

Having charge of location or other surveys for canals, waterways, dams, locks, pipe lines, or any of them.

Detailing elements or features of important projects the main features of which have been determined from the sketches and computations of designers, for example, establishing the grade of a trunk-line sewer of which the location, size, and shape have been determined, and locating manholes, designing intersections of arms with trunk lines and outlets, and determining the grades of lateral sewers.

Serving as project engineer in charge of a minor construction project or as assistant project engineer on a major one.

Doing work of equal difficulty and responsibility involving two or more such classes of processes, with or without other engineering work of like grade or

work of sub-professional, or of clerical or other non-engineering, character.

(3) *In sanitary engineering:* Performing such duties as are described in the preceding examples classified by engineering processes, primarily with respect to engineering projects involved in the protection and preservation of the health of communities, for example, projects for the removal and disposal of sewage and other wastes, as by:

Designing and preparing complete plans and estimates for parts of sewerage systems or elements of sewage treatment works of which the basic designs have been described and the sketches and calculations of the designers are available.

Serving as a project engineer on a minor project or as assistant project engineer of a major project involving construction of such systems or works.

Doing work of equal difficulty and responsibility involving two or more of such classes of processes or other civil engineering processes, with or without other engineering work of like grade, or work of sub-professional, or of clerical or other non-engineering, character.

(4) *In general:* Doing work of equal difficulty and responsibility involving two or more of the fields of practice described, or other civil engineering field of practice, with or without other engineering work of like grade, or work of sub-professional, or clerical or other non-engineering, character.

E. *Grade I Described by Examples of Characteristic Duties Classified by "Types of Organization":* The following illustrative combinations of duties grouped according to several of the more important types of organization and applicable to any class of engineering processes and any field of practice are typical of positions properly allocated to the grade:

(1) *In a state highway department:* As a member of a state highway department organization, doing such work as is described under the preceding headings with respect to highway construction, reconstruction, or maintenance, involving duties as to location, grades, pavements, bridges, drainage features, and culverts and other structures, as chief of survey party, as designer or draftsman, or as project engineer on construction, or in two or more of such capacities, or doing other professional civil engineering work of equal difficulty and responsibility, with or without other engineering work of like grade, or other work of sub-professional, or of clerical or other non-engineering, character, as by:

On preliminary, location, or final road surveys, establishing lines, taking cross-sections, making property and drainage surveys, taking soundings for structures, establishing lines, grades, angles, and contours; and establishing or verifying records of alignment, boundaries of rights of way, and ownership and limits of abutting properties.

Making plans involving new center lines and grades; designing typical slab cross-sections; preparing preliminary and final quantity estimates; and computing costs.

Supervising construction of roads, bridges, and drainage structures on projects of smaller size or less complex nature, calling for not more than one or two assistants, or serving as assistant project engineer on more extensive or more complex projects. Assisting generally, as directed, on office and field work involved in securing rights of way for proposed highway construction projects, as by mapping proposed locations and boundaries from survey field notes; making title searches; verifying legal descriptions; preparing right-of-way maps and descriptions of parcels of land required; investigating and reporting on ownership of properties; negotiating with owners and endeavoring to reach agreements.

(2) *In a municipal government establishment:* As an employee of a municipal government, doing such work as has been described under the preceding headings with relation to any of the processes and any of the fields of practice presented as examples or any combination of them, with respect to municipal activities, as by:

Having charge of a field party in making preliminary surveys for the location of public buildings, sewers, water works, bridges, streets, alleys, bridges, culverts, ditches, safety zones, sidewalks, parks, playgrounds, and other public improvements; making surveys for condemnation plats; laying out construction work; taking cross-section measurements of completed work; and making measurements and securing data as to conditions of ground soil, accessibility of work, and other facts bearing on estimates.

Preparing profiles, plans, working drawings, bills of materials, estimates, and cost distributions; preparing drawings for use in vacation and condemnation proceedings; making maps of subdivisions, drawing legal descriptions, compiling underground public improvement records.

Supervising a small group of draftsmen on such work.

Supervising labor foremen and inspecting contract work, as to projects, or portions of projects, involving such difficulty and responsibility as are consistent with the definition and the preceding examples given for the grade.

Conducting traffic surveys, in accordance with prescribed standards and procedures, involving the making of traffic counts, speed checks, and investigations of need for traffic control signs, signals, or officers, and making office compilations of data and charts and diagrams; assisting in developing traffic plans, and methods of direction.

Gathering city planning data on such factors as location and uses of property, trends in population, assessed valuations, tax delinquency, and other physical features and social and economic factors; preparing maps, charts, and graphs representing such data.

(3) *In an industrial establishment:* As an employee of a manufacturing or public utility company or an industrial organization of other type, doing such work as has been described under the preceding headings, with

relation to any of the processes in any of the fields of practice presented as examples, or any combination of them, for example:

With one or two assistants, doing technical engineering work under standardized methods and procedures in connection with construction, operation, or maintenance of plants, equipment, appliances, or other properties of the company; assisting in the performance of special engineering work and the solution of engineering problems as may be required; assisting on surveys and studies in connection with technical and engineering problems; collecting and preparing data for reports; preparing estimates on technical projects.

Preparing plans and estimates for structural features of plant buildings and other structures, complete as to minor structures, and by designing parts and supplying details for major structures the main features of which have been determined; computing stresses, determining sizes of members, selecting equipment, taking off quantities, preparing estimates of costs, and preparing contracts and working drawings.

Supervising construction work on structures of simple type or smaller size.

Securing data for appraisal and valuation of physical plants and equipment, applying established routine appraisal procedures to such data, and preparing preliminary analyses.

Grade II—Grade Definition

A. *Grade II Described in Terms of the General Nature of the Characteristic Duties:* Grade II includes all positions the duties of which involve civil engineering work of intermediate professional difficulty and responsibility, as such work is defined herein.

B. *Grade II Described in Terms of the Minimum Requisite Qualifications:* The positions of Grade II are further described with respect to the minimum qualifications requisite for the satisfactory performance of the duties characteristic of them, as follows:

(1) *As to general education and experience:* (*a*) Graduation with a degree in civil engineering from an engineering school on the accredited list of the Engineers' Council for Professional Development, and two years of experience in engineering work or its equivalent in graduate study, or (*b*) completion of the twelfth school grade with additional self-improvement through study of technical engineering subjects, and five years of experience on engineering work, or (*c*) any equivalent combination of education and experience.

(2) *As to general knowledge and skill:* Familiarity with mathematics through calculus, with physics, with the properties of materials used in construction, with engineering specifications, with the customs and practices followed in expressing engineering decisions in drawings, and with the important sources of engineering information; more than ordinary skill in the application of such knowledge to engineering problems; ability to organize engineering data and to draw logical conclusions therefrom and to present facts, findings, and definite conclusions clearly and concisely; ability to program, plan, organize, supervise, and check the work of others, and to lay out the working details of projects of minor scope.

(3) *As to specialized qualifications:* Special courses, or outside study, in technical engineering subjects germane to the specific work, or two years of experience on work in the sphere of specialization, and knowledge and skill in the subject matters and techniques involved in such work commensurate with the general engineering knowledge and skill requisite for the grade.

C. *Grade II Described by Examples of Characteristic Duties Classified by "Processes":* The following illustrative combinations of duties, grouped according to several of the more common engineering "processes," and applicable to any field of practice and type of organization, are typical of positions properly allocated to the grade:

(1) *In surveying processes:* Independently or under lay direction, with complete responsibility for the technical soundness of methods and the accuracy of results, having charge of surveys of minor difficulty and complexity, such as those described under the corresponding subhead for Grade I.

Under higher technical direction, with considerable latitude for independent action and judgment under approved policies and standards, having charge of a large survey party on topographic, hydrographic, triangulation, and other control, location, and property surveys, or any of them, not involving especially difficult problems, or of a small survey party on such surveys of especial difficulty or complexity, with duties and responsibilities in any such case similar to those described, under the corresponding subhead, for Grade I.

(2) *In designing and drafting processes:* Independently or under lay direction, doing work such as is described under the corresponding subhead, for Grade I.

Under higher technical direction, with considerable latitude for independent action and judgment under approved policies and standards:

Designing and preparing complete plans for various common types of engineering construction of more than minor importance and complexity, but not involving especially difficult or complex problems, involving the making and checking of computations; the preparation of preliminary studies, layouts, cost estimates, complete preliminary and final construction plans, project statements, contracts, maps, diagrams, and tabulations; and preparing and checking shop details of structural and reinforcing steel.

Having charge of a small group of engineers, draftsmen, and computers on difficult or varied work, involving simple design and preparation of plans, estimates, and specifications, or any of them, or a larger group or two or three small groups on more standardized or repetitive processes, with duties such as are described in the same connection under the corresponding subhead for Grade I.

(3) *In construction processes:* Independently, or under lay direction, having charge of a minor construction project with duties such as are described in the same

connection under the corresponding subhead for Grade I.

Under higher technical direction, with considerable latitude for independent action and judgment:

Serving as project engineer of a major construction project, but one not of exceptional size or complexity, with duties similar to those of the project engineer of a minor project as described under the corresponding subhead for Grade I.

(4) *In general:* Performing duties of equal difficulty and responsibility involving two or more of the kinds of processes described, or other engineering processes, with or without other work of sub-professional, or of administrative or other non-engineering, character.

D. *Grade II Described by Examples of Characteristic Duties Classified by "Fields of Practice":* The following illustrative combinations of duties, grouped according to several of the more important "fields of practice," and applicable to any classes of engineering processes and types of organization, are typical of positions properly allocated to the grade:

(1) *In structural engineering:* Doing such work as is described under the corresponding head for Grade I but of such difficulty and responsibility as described and illustrated under the preceding headings for this grade, as by:

Designing and preparing plans and estimates for a variety of common types of structures involving average range and difficulty of technical problems to be solved, for example, designing simple steel trusses, concrete slab and girder bridges, timber trestles, small truss bridges, and the structural work of buildings, checking and approving plans of the same order of difficulty prepared by others, and making investigations and reporting on the strength of existing buildings and safe floor loads.

Serving as leader of a large drafting-room group or two or more smaller ones, on simple or highly routinized details, or of a small one on more difficult structural design, computation, and drafting problems, with difficulty and responsibility commensurate with the grade.

Serving as project engineer on a construction project of major importance, but not the largest or most difficult, or supervising the project engineers on two or more minor projects.

Doing work of equal difficulty and responsibility involving two or more of such classes of processes or other civil engineering work, with or without other engineering work of like grade or work of sub-professional, or of clerical or other non-engineering, character.

(2) *In hydraulic engineering:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as described and illustrated under the preceding headings of the definition of this grade.

(3) *In sanitary engineering:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as is described and illustrated under the preceding headings of the definition of this grade.

(4) *In general:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as are described and illustrated under the preceding headings of the definition of this grade.

E. *Grade II Described by Examples of Characteristic Duties Classified by "Types of Organization":*

(1) *In a state highway department:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as are described and illustrated under the preceding headings of the definition of this grade.

(2) *In a municipal government establishment:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as are described and illustrated under the preceding headings of the definition of this grade.

(3) *In an industrial establishment:* Doing work such as is described under the corresponding subhead for Grade I, but of such difficulty and responsibility as are described and illustrated under the preceding headings of the definition of this grade.

Grade III—Grade Definition

A. *Grade III Described in Terms of the General Nature of Characteristic Duties:* Grade III includes all positions the duties of which involve civil engineering work of especial professional difficulty and responsibility, as such work is defined herein.

B. *Grade III Described in Terms of the Minimum Requisite Qualifications:* The positions of Grade III are further described with respect to the minimum qualifications requisite for the satisfactory performance of the duties characteristic of them, as follows:

(1) *As to general education and experience:* (*a*) Graduation with a degree in civil engineering from an engineering school on the accredited list of the Engineers' Council for Professional Development, and four years of experience in engineering work, or its equivalent in graduate study, or (*b*) completion of the twelfth school grade with additional self-improvement through study of technical engineering subjects, and seven years of experience on engineering work, or (*c*) any equivalent combination of education and experience.

(2) *As to general knowledge and skill:* Thorough familiarity with mathematics through calculus, with physics, with the properties of materials used in construction, with engineering specifications, with the customs and practices followed in expressing engineering decisions in drawings, and with the important sources of engineering information; a high degree of skill in the application of such knowledge to engineering problems; ability to organize engineering data and to draw logical conclusions therefrom and to present facts, findings, and definite conclusions clearly and concisely; ability to program, plan, organize, supervise, and check, the work of others, and to lay out the working details of projects of major scope.

(3) *As to specialized qualifications:* Special courses, or outside study, in technical engineering subjects germane to the specific work, or three years of experience

on work in the sphere of specialization, and a high degree of knowledge and skill in the subject matters and techniques involved in such work commensurate with the general engineering knowledge and skill requisite for the grade.

C. *Grade III Described by Examples of Characteristic Duties Classified by "Processes":* The following illustrative combinations of duties, grouped according to several of the more common engineering "processes," and applicable to any field of practice and any type of organization, are typical of positions properly allocated to the grade:

(1) *In surveying processes:* Independently, or under lay direction, with complete responsibility for the standards and methods applied and for the technical soundness of the methods and the accuracy and reliability of the results, doing work of such kinds as are described under the corresponding heading for Grade I and Grade II.

Under higher technical direction, but with wide latitude for independent action and judgment in accordance with approved plans, policies, and standards:

Having charge of a survey party, with duties such as are described under the corresponding subhead for Grade I and Grade II, where the problems and complexities are of outstandingly difficult and complex character.

Having general charge of an engineering survey project involving the gathering of engineering data over a wide area by means of a number of survey parties; planning and coordinating the work, making assignments of work to survey parties, prescribing standards and methods, issuing instructions, supervising the work in progress, checking reports of work done, and preparing reports thereon.

(2) *In designing and drafting processes:* Independently or under lay direction, with complete responsibility for the standards and methods applied and for the technical soundness of the work and the accuracy and reliability of the results, doing work of such kinds as are described under the corresponding heading for Grade I and Grade II.

Under higher technical direction, with wide latitude for independent action and judgment in accordance with approved plans, policies, and standards:

Designing construction projects involving especially difficult or complex problems.

Serving as specialist in a designing and drafting organization on special and difficult computations of stresses and other problems of design, advising other members as to details involving some field of specialization in difficult computation or design.

Serving as chief draftsman of a small designing and drafting organization or as assistant chief draftsman of a larger organization, or as head of a section or other unit of one still larger, with duties commensurate in any such case with those described in other parts of this definition.

(3) *In construction processes:* Independently, or under lay direction, with complete responsibility for the standards and methods applied and for the technical soundness of the work and the accuracy and reliability of the results, doing work of such kinds as are described under the corresponding heading for Grade I and Grade II.

Under higher technical direction, with wide latitude for independent action and judgment in accordance with approved plans, policies, and standards:

Serving as project engineer on a construction project of the largest and most difficult type commonly dealt with in a large organization, with duties and responsibilities such as are described for project engineers of Grade I and Grade II under the corresponding subheads for those grades.

Serving as resident engineer with responsibility for direction of the work of several project engineers of lower grade, and their assistants, in a designated area, and as such assigning work, making decisions as to methods and as to priority of construction work, and approving or securing approval of variations from plans and specifications made necessary by contingencies arising after construction work has begun; giving instructions, reviewing reports of project engineers, making frequent checks of work in process, passing upon difficult engineering and administrative problems in connection with such work, receiving and approving periodic and final reports, and keeping records of progress, budgets, and expenditures on the several projects.

(4) *In general:* Performing duties of equal difficulty and responsibility involving two or more of the classes of processes described, or other engineering processes, with or without other work of sub-professional, or of administrative or other non-engineering, character.

D. *Grade III Described by Examples of Characteristic Duties Classified by "Fields of Practice":* The following illustrative combinations of duties, grouped according to several of the more important "fields of practice," and applicable to any classes of engineering processes and any types of organization, are typical of positions properly allocated to the grade:

(1) *In structural engineering:* Doing such work as is described under the corresponding head for Grade I and Grade II but of such difficulty and responsibility as described under the preceding headings of this definition, in connection with surveying, designing and drafting, construction, or other processes. Specifically,

Having charge of several groups on field surveys for structures.

Serving as the specialized structural engineer or bridge designing engineer of an organization comprising a variety of engineering specialties, or as squad leader over a small group of structural or bridge designers and draftsmen, with responsibility for all structural design work.

Having charge as project engineer of an especially large and important structural project or supervising two or more project engineers of lower grade on such project.

Doing work of like grade involving two or more of such processes, with or without other work of greater difficulty and responsibility.

(2) *In hydraulic engineering:* Doing work such as is described under the corresponding subhead for Grade I and Grade II, but of such difficulty and responsibility as described under the preceding headings of this definition.

(3) *In sanitary engineering:* Doing work such as is described under the corresponding subhead for Grade I and Grade II, but of such difficulty and responsibility as described under the preceding headings of this definition.

(4) *In general:* Doing work such as is described under the corresponding subhead for Grade I and Grade II, but of such difficulty and responsibility as described under the preceding headings of this definition.

E. *Grade III Described by Examples of Characteristic Duties Classified by "Types of Organization":*

(1) *In a state highway department:* Doing work such as is described under the corresponding subhead of Grade I and Grade II, but of such difficulty and responsibility as are described and illustrated under the preceding headings of this definition.

(2) *In a municipal government establishment:* Doing work such as is described under the corresponding subhead of Grade I and Grade II, but of such difficulty and responsibility as are described and illustrated under the preceding headings of this definition.

(3) *In an industrial establishment:* Doing work such as is described under the corresponding subhead of Grade I and Grade II, but of such difficulty and responsibility as are described and illustrated under the preceding headings of this definition.

Scales of Compensation for the First Three Professional Grades

	Monthly Rate	Yearly Rate	Intervals Between Rate
For Grade I			
Starting Rate	$170.00	$2,040.00	
			$480.00
Full Rate	210.00	2,520.00	
			$120.00
For Grade II			
Starting Rate	220.00	2,640.00	
			$480.00
Full Rate	260.00	3,120.00	
			$180.00
For Grade III			
Starting Rate	275.00	3,300.00	
			$540.00
Full Rate	320.00	3,840.00	

EXPLANATORY NOTES

1. The compensation scales presented in this schedule represent the levels of pay that are deemed to be right for positions of the respective grades described in the grade definitions. They represent the Society's conclusions as to fair levels of pay for work in positions of the several grades as arrived at from consideration of the actual levels of pay for such positions now in effect, those for other comparable employments in public and private services, and those that have been recommended by various agencies that have made studies with relation to appropriate salaries for engineers.

2. These scales are intended to be used as standards against which to measure salaries now being paid, and to be so used with judgment as to any need for differentials by reason of higher costs of living and higher general salary levels prevailing in any given city or other geographic area, or under any other special conditions. The scales in certain local areas where the conditions justify may well be expected to exceed those here presented by 25% or more.

3. The starting rate in the scale for each grade represents the amount that is the least that should be paid to a qualified appointee to a position of the grade, and the full rate represents the amount that should normally be paid to the employee who has had a full experience and has demonstrated his fitness to render a full measure of service in the position. In a case where any employee has demonstrated ability to render service of exceptional value beyond that normally to be expected of an employee in such a position, payment at a higher rate than the maximum of the applicable scale should be deemed to be warranted.

4. It is recommended that each scale in its application in the service of any particular employer include certain intermediate rates, representing steps for salary increases within the ranges of the scales. The scales for Grade I and Grade II should have three such intermediate rates, or five rates in all in each scale, separated by intervals of $120 a year, or $10 a month. Grade III should have two intermediate rates or four rates in all, separated by intervals of $180 a year, or $15 a month. It is contemplated that, in practice, a new appointee to a position will ordinarily be paid at the starting rate of the scale for the grade to which his position belongs. The first increase should come fairly soon thereafter to an employe who shows himself deserving of it, say in six months to a year after appointment. Later increases will naturally be spaced farther and farther apart, with a progressive flattening of the curve of advancement, to the full rate for the grade in question and in exceptional cases, with increases beyond the full rate after still longer periods of service.

Definitions of Terms

In the grading plan and compensation schedule, the following-named terms are used in the special, technical senses indicated. They are arranged in alphabetical order.

Civil Engineering—All engineering exclusive of such formally and definitely recognized specialized branches as mechanical, electrical, mining and metallurgical, and chemical engineering.

Class or *Class of Positions*—A definitely recognized kind of position such that, of any two or more positions properly determined to be of such kind, the duties are so nearly alike that the positions and their incumbents may fairly and equitably be treated alike for all purposes involving employment processes, such as the prescribing and testing of qualifications of applicants for appointment, and the determining of rates of compensation.

Compensation—Salary, wages, allowances, and other forms of valuable consideration, or any combination of them, earned by, or paid to, an employee in consideration of the performance of the duties of a position.

Difficulty—Quality or state of being hard to do or to understand and of requiring understanding, skill, and effort for the achievement of results.

Education and Experience—The aggregate for any individual of (*a*) the formal schooling, (*b*) the informal training represented by self improvement through reading,

study, and experiment, and (*c*) the actual application of time and effort in work that is directed toward, or is of a nature adapted to, providing such background of knowledge and such specific skill as are necessary to entering upon the performance of duties of any specified kind with reasonable prospects of success in their performance. Where stated years of formal education or experience are specified, it is to be understood that these are by way of measures only, and that experience and informal training may be substituted for the formal education specified, and further formal or informal training may be substituted for the experience specified, to the extent that they are deemed to represent equivalent preparation for the assumption of such duties.

Employee—The incumbent of a position, charged with performing the duties and exercising the responsibilities thereof.

Engineering—That branch of human endeavor which involves the application of physical laws and the principles of mensuration and properties of materials to physical works or devices.

Engineering Process—An engineering operation or group of operations involved in effecting an engineering purpose such as the surveying, the designing and drafting, or the construction processes.

Field of Practice—A recognized branch of professional endeavor calling for the application of engineering processes primarily to a restricted purpose or group of purposes and involving a distinct category of practical applications of physical laws, such as the structural, hydraulic, or sanitary fields of engineering practice.

Grade or *Grade of Positions*—A rank or level of positions as determined by the combined technical and administrative difficulty and responsibility of the duties of the positions in relation to the ranks or levels of positions of higher and lower grades. Each grade represents a range in these respects, but a range as narrow as practical considerations involved in the definition, identification, and practical application of the grade limitations, in practical operation, are deemed to permit. *Note:* The several grades established in the accompanying grading plan are divisions into strata, bands, or levels of the lowest range of positions constituting the profession, each level calculated to embrace positions nearly enough alike with respect to the criteria determining relative rank so that they may fairly and equitably be treated alike in all ways that depend upon ranking factors, and particularly that they may be treated alike in the determination of appropriate rates of compensation to be applied to them and their incumbents. Each grade is conceived to embrace numerous specific classes (not developed as parts of the accompanying grading plan) based upon the "kinds" of positions, as kind is determined by characteristics relating to subject matter or type of work rather than difficulty or responsibility of work.

Minimum Requisite Qualifications—The least qualifications that should normally be deemed to be sufficient to entitle a person to consideration for appointment to a position of a grade as defined. The specific qualifications stated are to be treated as minimum standards against which to measure the qualifications possessed by individuals under consideration for appointment. These minimum standards, of course, are not to govern where individuals with higher qualifications are available.

Position—An elective or appointive office or an employment involving an aggregation of duties to be performed and responsibilities to be exercised by one person.

Professional—Representing an order of technical competence and of ability to exercise judgment and to carry responsibility with respect to technical work in a degree equal to, or superior to, the minimum commonly associated with one engaged in any of the recognized professions.

Professional Difficulty and Responsibility—The combination of difficulty and of responsibility, as separately defined, in the duties of a position of professional character, that affords a basis for measuring the degree of technical competence, ability to exercise professional judgment, and ability to carry professional responsibility requisite for successful performance of the duties of the position. Degrees of professional difficulty and responsibility in the accompanying grade definitions are expressed as follows: *Least*, within such range as is consonant with the qualifications described and the examples set forth in the definition for Grade I. *Intermediate*, distinctly higher than "least" as defined, and within such range as is consonant with the qualifications described and the examples set forth in the definition for Grade II. *Especial*, distinctly higher than "intermediate," as defined, and within such range as is consonant with the qualifications described and the examples set forth in the definition for Grade III.

Rate of Compensation—Compensation expressed in terms of some unit of time or other basis of measurement, such as the amount earned in an hour, day, or year.

Responsibility—Accountability for results, as through the efforts of others whose work is planned, assigned, and supervised, or through personal efforts where the results are intended to be relied upon by others.

Routine—Involving a round of processes daily or otherwise frequently pursued.

Scale of Compensation—A series of rates of compensation consisting of a minimum and a maximum and, at times, of one or more intermediate rates.

Skill—Expertness in carrying out specific operations and applying them for the accomplishment of definite objectives.

Simple—Easily learned, as applied to specified kinds of tasks performed or to be performed, by a normal person qualified generally by background, training, and experience to undertake the performance of such tasks, without necessity for prior training or experience in the performance of the particular kinds of tasks specified.

Sub-Professional—Of technical character, but of a level of requirements as to competence, judgment, and ability lower than the lowest professional level.

Technical—Involving processes and operations specially adapted to securing desired results through the application of a science or a practical art to a practical purpose; in this project, the design or construction of civil engineering works.

Type of Organization—A kind of establishment, operating unit, business establishment, or public body in which a position has its place, such as a state highway department, a municipal government service, or an industrial establishment.

ENGINEERS' NOTEBOOK

This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems. Reprints of the complete department, 8½ by 11 in., suitable for binding in loose-leaf style, are available each month at 15 cents a copy.

Suggestions on Use of the Conjugate Beam Method

By A. M. Ockerblad, M. Am. Soc. C.E.

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It is the object of this article to present a new idea regarding the directions of the elastic loads on conjugate beams, together with a logical correlation of the sign of the shear and the moment. The reader is assumed to have a general working knowledge of the conjugate beam method as set forth by H. M. Westergaard, M. Am. Soc. C.E., in his paper, "Deflection of Beams by the Conjugate Beam Method" (*Journal of the Western Society of Engineers*, November 1921, Vol. 26, page 369).

In both the given beam and the conjugate beam, shear is assumed, as is usual, to be the algebraic sum of the loads to the left of the section. Moment in a beam is assumed to be positive if it causes tension in the bottom of the beam; or, what is the same thing, internal moment in a beam is assumed to be obtained by taking the moment of the loads on one side of the section and assigning a positive sign to the moment of the upward forces and a negative sign to the moment of the downward forces.

Now, by establishing the sign of the moment in those given beams in which this is possible, the direction of the resulting elastic load on the conjugate beam is determined. For a positive moment in the given beam, a positive area, or one acting in a positive direction (upward), results in the conjugate beam. For a negative moment in the given beam, a negative area, or one acting downward, is placed on the conjugate beam. This results in general in several loads on the conjugate beam, some upward and some downward. The manner of supporting the conjugate beam is determined from the conditions of the slope and deflection of the given beam at the ends and stated points as usual. Quite often the reactions act downward to oppose an upward elastic load.

To illustrate, let us consider a few easily checked determinate beams. Take as a first example a cantilever beam fixed at the right end, as shown in Fig. 1.

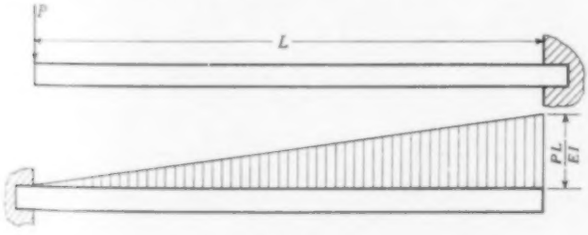

Fig. 1

The conjugate beam is shown below the given beam, with the elastic load placed on it. Since the internal moment in the given beam is negative, the resulting elastic load on the conjugate beam acts downward. Of course the right end of the conjugate beam is free because the deflection and slope in the given beam are zero at the right end, and the left end of the conjugate beam is fixed, as the deflection and slope at the left end of the given beam are other than zero. The shear in the conjugate beam at the left end is

$$V = + \frac{PL}{EI} \cdot \frac{L}{2} = + \frac{PL^2}{2EI}$$

and the plus sign indicates slope upward and to the right in the given beam. The moment in the conjugate beam at the left end is

$$M = - \frac{PL^2}{2EI} \cdot \frac{2L}{3} = \frac{-PL^3}{3EI}$$

This sign is minus because the elastic load acts downward (or because it puts tension in the top of the conjugate beam) and signifies that the deflection in the given beam at the left end is downward.

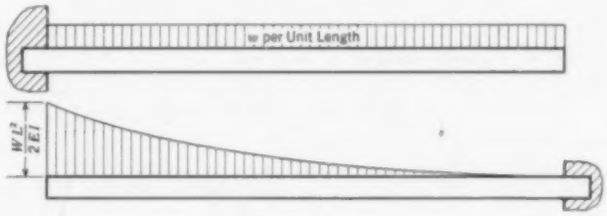

Fig. 2

As another example consider a cantiliver fixed at the left end and carrying a uniformly distributed load (Fig. 2). The shear in the conjugate beam at the right end is

$$V = - \frac{wL^2}{2EI} \cdot \frac{L}{3} = - \frac{wL^3}{6EI}$$

This indicates slope downward and to the right in the given beam at the right end. The moment in the conjugate beam at the right end is

$$M = - \frac{wL^3}{6EI} \cdot \frac{3L}{4} = - \frac{wL^4}{8EI}$$

This indicates that the deflection at the right end of the given beam is downward.

Again, consider a simple beam with a load at the middle (Fig. 3). The moment in the given beam is positive, giving rise to a positive elastic load on the conjugate beam, which is a maximum of $+ \frac{PL}{4EI}$ at the center. Since the deflection and slope at either end of the given beam have respectively a value of zero and a real value, the moment in the conjugate beam at either end must be zero and the shear at either end must not be zero. To satisfy these conditions there must be a reaction at each end of the conjugate beam, and as the elastic load acts upward the conjugate reactions must act downward.

The shear in the conjugate beam at the respective ends is

$$v_l = -\frac{PL^2}{16EI} \qquad v_r = +\frac{PL^2}{16EI}$$

This indicates slope downward and to the right at the left end, and upward and to the right at the right end.

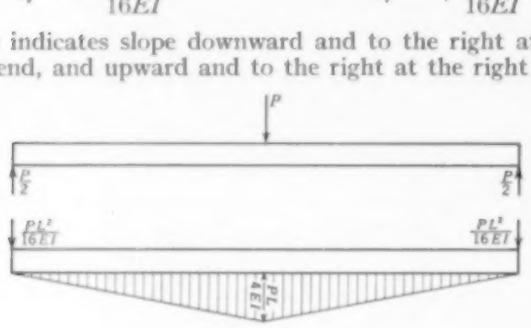

FIG. 3

The maximum moment in the conjugate beam occurs at the middle, or where the shear in the conjugate beam is zero, and is $M = -PL^2/48EI$.

These three examples have been selected to show how the shear in the conjugate beam governs the amount as well as the sign of the slope in the given beam, and how the moment in the conjugate beam governs the amount and sign of the deflection in the given beam.

The conjugate beam method finds its greatest use in the field of indeterminate structures. Before proceeding to an example, let us consider the effect of the assumption of sign upon the algebraic work. When the signs of the moment and shear in the given beam are unknown it is best to assume them to be plus. If this is done, then if the signs from the results of the algebraic equations are plus, the results are plus; while if the signs are minus, the results are minus. If, on the other hand, it is elected to assume the signs of the unknown moments and shears to be minus, then if these are introduced into the algebraic equations the resulting values, if plus, check the assumption of minus sign, while if minus, they deny the assumption of minus sign and are plus. On this account, when a sign is unknown it should be assumed to be plus.

Consider now the case of a beam fixed at both ends and carrying a uniformly distributed load. Let the tangent to the elastic line of the beam at the points of fixation be horizontal (Fig. 4). The moment at any point in the given beam is

$$M_x = M_l + V_l x - \frac{wx^2}{2}$$

The M/EI diagram can therefore consist of three areas, one for each of the three parts of the right-hand member. Since the deflection and slope at each end of the given beam are zero, the moment and shear at each end of the conjugate beam must be zero, and this condition is attained by leaving the ends unsupported. The conjugate

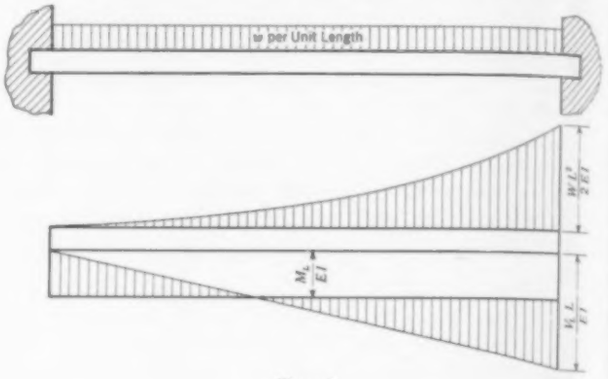

FIG. 4

beam floats under the effect of the elastic load. The summation of the vertical forces is

$$-\frac{wL^2}{2EI}\cdot\frac{L}{3}+\frac{M}{EI}\cdot L+\frac{V_l L}{EI}\cdot\frac{L}{2}=0$$

and the summation of moments about the right end of the conjugate beam is

$$-\frac{wL^2}{2EI}\cdot\frac{L}{3}\cdot\frac{L}{4}+\frac{M}{EI}\cdot L\cdot\frac{L}{2}+\frac{V_l\cdot L}{EI}\cdot\frac{L}{2}\cdot\frac{L}{3}=0$$

The solution of these equations is

$$V_l = \frac{+wL}{2} \qquad M_l = \frac{-wL^2}{12}$$

whence we see immediately that the slopes and deflections in the given beam are obtained in amount and sign by the conjugate beam method when due attention is paid to the direction of the elastic load.

Calculating the Volume of a Truncated Spherical Segment

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IN connection with containers, such as marine fuel tanks, consisting of horizontal cylinders with heads formed in the shape of spherical segments, as shown in Fig. 1, it becomes desirable to construct calibration curves giving the contents corresponding to various values of the depth, h. The required calculation involves finding the volume of the cylindrical segment and that of the truncated spherical segments at the ends of the vessel. The former portion offers no difficulty, but the truncated spherical segment presents a rather tedious problem in integration.

In Fig. 2 is shown a sphere of radius R cut into quarters by a pair of mutually perpendicular planes whose traces are represented by the X and Y axes. Parallel to the central vertical plane and at a distance aR therefrom is a plane representing the end of the cylindrical portion of the container in Fig. 1, which intersects the sphere on a circle with a radius of $R\sqrt{1-a^2}$. Hence $a = \sqrt{1-\left(\frac{R'}{R}\right)^2}$, where R' is the radius of the cylinder. Parallel to the central horizontal plane and at a distance

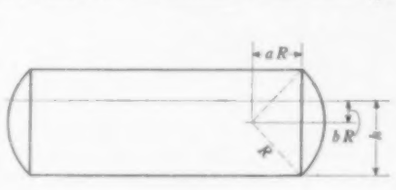

FIG. 1

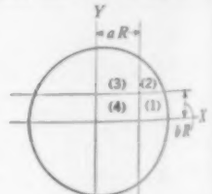

FIG. 2

bR therefrom is a plane representing the level of the contents of the vessel in Fig. 1, which intersects the sphere on a circle with a radius of $R\sqrt{1-b^2}$. These two planes cut the upper right-hand quarter of the sphere into four parts, numbered 1 to 4 in Fig. 2, whose volumes, denoted by V_1, V_2, V_3, and V_4, respectively, are related as follows:

$$V_1 + V_2 = \frac{\pi R^3}{3}\left(1 - \frac{3a - a^3}{2}\right) \quad \ldots\ldots [1]$$

$$V_2 + V_3 = \frac{\pi R^3}{3}\left(1 - \frac{3b - b^3}{2}\right) \quad \ldots\ldots [2]$$

$$V_3 + V_4 = \frac{\pi R^3}{3}\left(\frac{3a - a^3}{2}\right) \quad \ldots\ldots [3]$$

$$V_1 + V_4 = \frac{\pi R^3}{3}\left(\frac{3b - b^3}{2}\right) \quad \ldots\ldots [4]$$

Using the abbreviation, $e = \sqrt{1 - a^2 - b^2}$ . . . . . [5] the expression obtained by the writer for the volume V_1 is:

$$V_1 = \frac{\pi R^3}{3}\left\{-\frac{2\,abe}{\pi} + \frac{1}{180}\left[(3b - b^3)\cot^{-1}\frac{a}{e} - (3a - a^3)\tan^{-1}\frac{b}{e} + 2\tan^{-1}\frac{ab}{e}\right]\right\} \quad [6]$$

The contents of the segmental head is then given by $\frac{\pi R^3}{3}\left(1 - \frac{3a - a^3}{2}\right) \pm V_1$, the sign being positive or negative according to whether the level of the contents is above or below the mid-height.

In practice, it is often desirable to also calculate V_2, V_3, and V_4 (Fig. 2), as in this way the results may be checked against Eqs. 1 to 4, inclusive. These volumes are as follows:

$$V_2 = \frac{\pi R^3}{3}\left\{\frac{2\,abe}{\pi} + \frac{1}{180}\left[-(3b - b^3)\cot^{-1}\frac{a}{e} - (3a - a^3)\cot^{-1}\frac{b}{e} + 2\cot^{-1}\frac{ab}{e}\right]\right\} \quad [7]$$

$$V_3 = \frac{\pi R^3}{3}\left\{-\frac{2\,abe}{\pi} + \frac{1}{180}\left[-(3b - b^3)\tan^{-1}\frac{a}{e} + (3a - a^3)\cot^{-1}\frac{b}{e} + 2\tan^{-1}\frac{ab}{e}\right]\right\} \quad [8]$$

$$V_4 = \frac{\pi R^3}{3}\left\{\frac{2\,abe}{\pi} + \frac{1}{180}\left[(3b - b^3)\tan^{-1}\frac{a}{e} + (3a - a^3)\tan^{-1}\frac{b}{e} - 2\tan^{-1}\frac{ab}{e}\right]\right\} \quad [9]$$

The angles whose tangents or cotangents are $\frac{a}{e}$, $\frac{b}{e}$, and $\frac{ab}{e}$ are expressed in degrees, and are first-quadrant angles.

Concrete Controls for Stream-Gaging Stations

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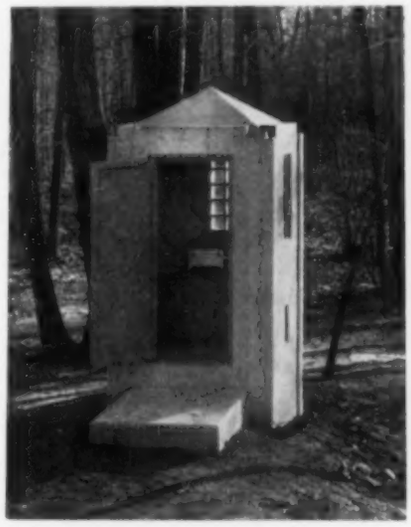
CONCRETE controls are being constructed at many of the stream-gaging stations maintained by the U. S Geological Survey in New Jersey for the purpose of stabilizing the stage-discharge relations at those stations

GENERAL VIEW OF THE CONTROL AND GAGE SHELTER ON THE RAHWAY RIVER NEAR SPRINGFIELD, N.J.

and of increasing the accuracy of the discharge determinations. These controls necessarily must be kept low to avoid damage by the flooding of property at times of high water. This height limitation usually prevents the use of sharp-crested weirs, which require sufficient height to provide a pool above the weir and free fall into the tailwater below.

The gaging station on the Rahway River near Springfield, N.J., shown in an accompanying photograph, is typical of stations now being established in New Jersey by the Geological Survey. The control is a low, broad-crested weir with a cross-section having a flat top and slopes of 1:1 on the upstream and downstream sides. The corners are rounded with curves of 8-in. radius (Fig. 1).

In order to measure low flows more accurately, the crest of the control is in the form of a flat V spanning the width of the stream, the low point being at the center of the channel and the top of the V at the sides. No predetermined slopes are used for the flat V-shape of the crest. At each station the height of the crest at the center and that at the banks are selected after an examination of



THIS CONCRETE SHELTER HOUSES THE RECORDING GAGE
Float Is Suspended in Well Beneath

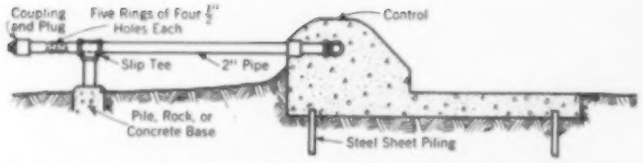


FIG. 1. CROSS-SECTION OF "TRENTON-TYPE" CONTROL, SHOWING INTAKE PIPE

the cross-section of the stream and the discharge capacity of the channel downstream from the control.

The height of water at the control is recorded by an automatic water-stage recorder installed in a concrete shelter on the bank of the stream opposite the end of the control. The float well under the shelter is connected with the stream by a 2-in. pipe embedded in the concrete control; this pipe is provided with two inlets, one at each of the quarter points of the stream. These inlets must be placed high enough so as not to be covered by material that may be deposited in the channel, and they must be low enough to insure their being under water at all times. A single inlet at the center of the stream where the velocity is greatest would indicate a gage he ght subject to the largest velocity of approach. The two inlets at the quarter points are in the regions of lower velocities, and also tend to average the heights of water on the two sides of the stream.

Several years' experience with this type of control for streams in New Jersey indicates that, for many of these structures, no deposit takes place behind the control. In no case do we find a deposit of silt or gravel at elevations higher than the foot of the 1:1 slope at the upstream side of the control.

A full-size model of this control has been rated for heads up to 0.8 ft at the National Hydraulic Laboratory, National Bureau of Standards. The control was rated for free fall and also with various conditions of submergence. A submergence of 65 per cent or less affected the discharge rating less than 1 per cent, and the effect was only 2 per cent with 80 per cent submergence (Fig. 2).

The discharge ratings of the gaging stations are determined by means of current-meter measurements of discharge made from time to time at various stages. These ratings generally agree with the laboratory rating at low stages, but diverge from the laboratory rating at high stages. This divergence is due, principally, to the different conditions of velocity of approach at the various stations.

Stream gaging by the Geological Survey in New Jersey is conducted in cooperation with the State Water Policy Commission, the North Jersey District Water Supply Commission, and the Delaware River Joint Toll Bridge Commission.

The gaging station on the Rahway River near Springfield, N.J., and stations on several other rivers in New Jersey were constructed by the U. S. Works Progress Administration through projects sponsored by the Geological Survey.

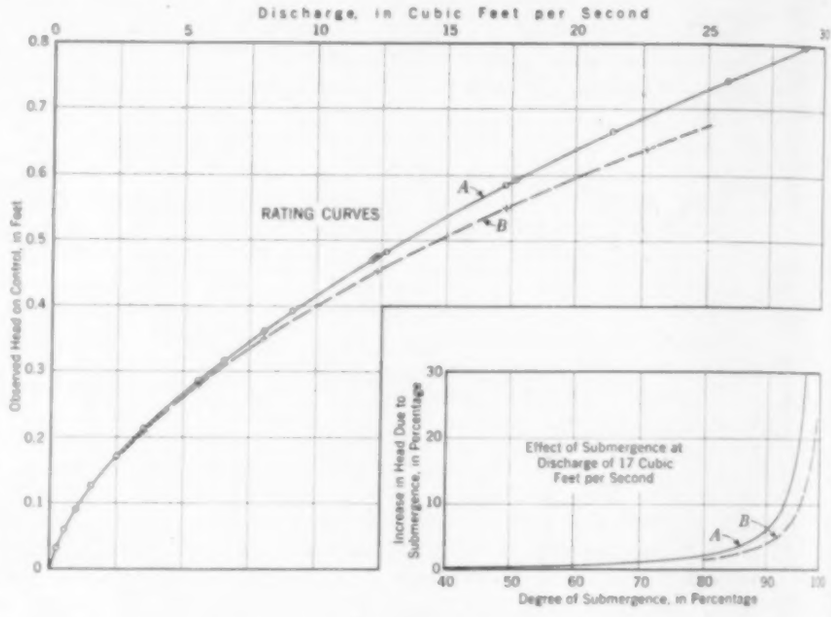

Discharge, in Cubic Feet per Second
Observed Head on Control, in Feet
RATING CURVES
A
B
Increase in Head Due to Submergence, in Percentage
Effect of Submergence at Discharge of 17 Cubic Feet per Second
Degree of Submergence, in Percentage

FIG. 2. RATING CURVES FOR FREE-FALL CONDITIONS, AND CURVES SHOWING EFFECT OF SUBMERGENCE

Length of Crest, 11.77 Ft. For Curves *A*, Crest Was 2.61 Ft Above Bottom of Approach Channel; for Curves *B*, the Height Was 0.37 Ft. Submergence Is Defined as Ratio of Height of Downstream Water Surface to Upstream Water Surface, Measured from Lowest Part of Crest of Control

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Engineering History

DEAR SIR: It is surprising what a lot of misinformation is current on the history of engineering. Thus I must regret Dean Agg's attempt (in the editorial, "Engineering in This New Era," in the November issue) to take the period from 500 B.C. to 1700 A.D.—some twenty-odd centuries of civilization, and of engineering progress and advance—as he says, "at a gulp." To begin with, his dates are purely arbitrary, and I fear that his "gulp" at "the outstanding progress" of these centuries conveys an entirely erroneous impression of the past history and accomplishments of our profession.

The date of 5000 B.C. for the beginning of civilization would be much nearer the truth than 500 B.C., which Dean Agg gives. Certain it is that at the time of the Old Kingdom in Egypt—the Pyramid Age, or approximately 300 B.C.—there had already been an industrial revolution in Egypt. The earlier agricultural life had been supplemented by the arts and crafts, and the Nile was filled with the shipping of a complicated and extensive economy which probably involved a population numbered in the millions. Those (to our minds) elaborately useless monuments of this period, the pyramids, at least prove that this national economy had been developed to the point where there was sufficient surplus available to make their construction possible. This was the age of

Imhotep, "the Father of Masonry Construction," who occupied a position of leadership in the life of his day which, unfortunately, the engineer has never since been able to achieve.

Thus the work of the engineer even before 500 B.C. cannot be dismissed in one gulp. Later, the Greek *architekton*, the Roman *architectus*, the medieval *ingineator*, the *engineer* of the Renaissance—all undertook works which even today would be considered of the first magnitude. Their labors cannot even be adequately summarized in five paragraphs.

It is the modern way, of course, to dismiss everything previous to our own time as insignificant and relatively unimportant. But the truth is that not until the past century has there been a development which even paralleled that of the Pyramid Age of fifty centuries ago, and until very recent years thousands of Americans have lacked many of the necessities and comforts of life which the Roman citizen enjoyed two thousand years ago.

No engineer would attempt to generalize about any field of technical activity until he had made a special and detailed study of this field. When we turn historians, however, we are apt to think this rule no longer holds. As a matter of fact, no generalizing is more difficult or dangerous than historical generalization. Let us beware, therefore, of broadcasting false ideas by attempting to put in a nutshell the aspirations and achievements of the centuries.

Indeed it seems probable that man has changed little during these centuries and that the engineer's work today is greater, not because of his greater capacity and abilities, but because he has the accumulated knowledge and experience of those earlier times with which to work. Our early ancestors did a fine job, but they worked—as we do—under the limitations imposed by the available materials, labor, and power, and by the economic and social demands of their day. It is doubtful if we, in their place, could have done better. Thus their achievements cannot be dismissed as insignificant and unimportant, or as premature and sporadic manifestations of an art which was only to blossom into full fruition with the advent of the year 1700 A.D.

Engineering is as old as civilization, and even an H. G. Wells took two fat volumes to give us an outline of that.

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New York, N.Y.

The Black River Regulating District

TO THE EDITOR: The operation of a system of reservoirs in the Black River Regulating District confirms Mr. Sargent's conclusion (in his article on the "Operation of Sacandaga Reservoir" in the November issue), that is, it is wholly practicable to operate a river-regulating reservoir for flood relief, low-water control, water power, navigation, and other purposes.

The Black River drains an area of 1,916 sq miles on the westerly slope of the Adirondack Plateau, and the following remarks apply primarily to the Adirondack rivers, which have the general characteristics of the streams of the Northeastern states. In the Black River Regulating District, which was organized in 1919, three reservoirs are now in operation, of which the Stillwater Reservoir on the Beaver River, with a capacity of 103,000 acre-feet, is the largest. The other two are the Old Forge and the Sixth Lake reservoirs on the Middle Branch of the Moose River.

The Stillwater Reservoir, controlling a drainage area of 172 sq miles, was completed in 1925, and the results of thirteen years of successful operating experience are now available. During this period the power plants and the paper mills on the Beaver River have operated at substantially full capacity, with no floods and no summer close-downs because of shortage of water, although the years 1930, 1933, and 1934 were among the driest on record, and one of the highest floods on record occurred in the spring of 1928.

For illustration, the regulated flow of the Beaver River during the period may be compared with that of the unregulated flow of the South Branch of the Moose River, which parallels the Beaver and lies a few miles to the south, both streams being tributaries of the Black. During the moderate flood of November 1938, the flow of the Moose reached a peak of 39 cu ft per sec per sq mile, while the Beaver rose to only 7 cu ft per sec per sq mile.

The Stillwater Reservoir has a capacity of approximately 11 in., or a little more than one-third of the annual runoff. It has been completely emptied only three times in the past 13 seasons, and in two years the spring runoff was not quite sufficient to fill the reservoir. The total quantity of water released for regulating purposes has averaged substantially 100 per cent of its capacity.

With respect to flood control, it may be said that in the Black River area, as in the Hudson, it probably would not be economical to build reservoirs for flood control alone. If the reservoirs here contemplated are to be justified on an economic basis, they must serve several purposes, including not only flood control, but also the improvement of the water powers upon which the industrial life of the district is founded.

Experience in this area shows that a storage capacity of 50 per cent of the annual runoff is sufficient for a high degree of flow regulation and a large measure of flood protection. If a retarding basin with a capacity of 6 in. of runoff can be superimposed upon a regulating reservoir with a capacity one-third that of the annual runoff, practically complete protection from floods can be assured, and reasonably good low-water control can be provided. These statements apply to the stream in the immediate vicinity of the reservoir, but if the reservoir is to be regulated for some downstream point, with a materially larger drainage area, a greater storage capacity will be needed.

While multiple-service reservoirs can be successfully operated for several purposes, such reservoirs will not be 100 per cent effective for every purpose. Compromise will be necessary in cases of conflicting usage, but the aggregate benefit to the community can be made far greater than would be possible if the reservoirs were operated for only a single purpose.

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Watertown, N.Y. *Hydraulic Engineer*

Flagpole Deflection Problem

TO THE EDITOR: The flagpole deflection problem, presented in the July issue by R. Reuben Kohn and discussed in the November issue by A. W. Fischer and by David A. Molitor, can be solved in an interesting manner by applying the theory of difference equations or finite differences.

Using the moment area principle and the known properties of the curves concerned, the solution for the wind load acting alone takes the form shown in Fig. 1.

At the base of the first segment from the top, the moment is $\frac{W_1 l_1}{2}$. The curve in this segment is parabolic and its area is $\frac{1}{3} \times \frac{W_1 l_1}{2} \times l_1$. The distance to its centroid is $^3/_4\, l_1$. Therefore the deflection at the top of the flagpole due to bending of this segment is $W_1 l_1^3 / 8\, EI_1$.

At the base of the second segment the moment is:

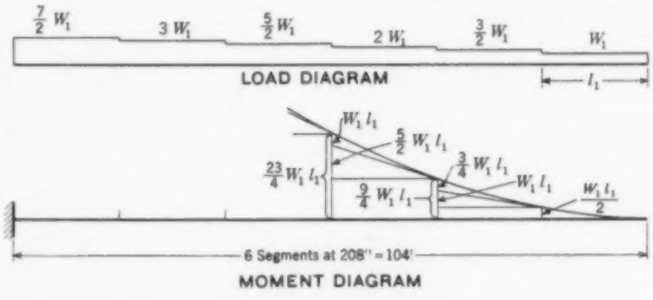

FIG. 1

$$\frac{W_1 l_1}{2} + W_1 l_1 + \frac{3}{2} W_1 \frac{l_1}{2}$$

The area under the curve in this segment can be divided into a rectangular, a triangular, and a parabolic area, corresponding to each of the above terms. This area is:

$$\frac{W_1 l_1}{2} l_1 + W_1 l_1 \frac{l_1}{2} + \frac{3}{4} W_1 l_1 \times 1/3\, l_1$$

Taking the moments of each area about the top of the pole, the deflection due to bending of this segment is:

$$\frac{\frac{3W_1l_1^2}{4}+\frac{5}{6}W_1l_1^2+\frac{7}{16}W_1l_1^2}{EI_2}$$

Continuing this process and combining results, the deflection, Δ, is:

$$\Delta=\frac{W_1l_1^2}{48E}\left(\frac{6}{I_1}+\frac{97}{I_2}+\frac{474}{I_3}+\frac{1{,}437}{I_4}+\frac{3{,}382}{I_5}+\frac{6{,}801}{I_6}\right)$$

The coefficients 6, 97, 474, etc., form a series, each term of which can be represented by C_n where n is the number of the segment from the top. By the principles of difference equations (Nörlund, "Differenzenrechnung," Bleich-Melan, "Die Gewöhnlichen und Partiellen Differenzgleichungen der Baustatik," Boole's "Finite Differences"), $C_n = 6 + 91\,(n-1) + 143\,(n-1)\,(n-2) + 50\,(n-1)\,(n-2)\,(n-3) + 4(n-1)\,(n-2)\,(n-3)\,(n-4)$ and

$$\Delta=\frac{W_1l_1^2}{48E}\sum_{n=1}^{n=r}\frac{C_n}{I_n} \quad \ldots\ldots\ldots [1]$$

Where r = number of segments.
Similarly, for the concentrated load at top,

$$\Delta=\frac{Pl_1^3}{3E}\sum_{n\ 1}^{n=r}\frac{C_n'}{I_n} \quad \ldots\ldots\ldots [2]$$

Where P = load at top,
and $C_n' = 1 + 3n\,(n-1)$
Applying these two equations, I find

Δ (for wind load)	$= 35.99''$
Δ (for flag)	$= 36.83$
Δ (total)	$= 72.82''$

Thus, Eqs. 1 and 2 form a general solution for any number of segments.

JOSEPH A. WISE, M. Am. Soc. C.E.
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Minneapolis, Minn.

Advances in Pollution Control

TO THE EDITOR: The abatement of water pollution in New York State during recent years is the result of many forces and interests laboring separately and cooperatively.

Through association with the engineer members of the State Health Department, I believe with Mr. Dappert (see "Progress in Control of Water Pollution in New York State," in the November issue of CIVIL ENGINEERING) that much of the progress made during the past ten years in controlling stream pollution in the state is due "to the cooperative, educational, and promotional activities" of the Department staff. The State Conservation Commission, assisted by the New York State Conservation Council, through fines and the exercise of police power, has also effectively reduced stream pollution.

One of the most outstanding influences of the depression decade in decreasing water pollution in New York State, as well as in the nation, is the use of federal funds for the construction of sewerage systems and of sewage treatment plants. "Between August 1935 and February 1938 nearly 1,600 community sanitation projects were undertaken in the state of New York. These works involved the expenditure of about $60,000,000 including $43,000,000 in federal aid and have effected needed improvements in local sanitation which could not have been financed without federal assistance." (*Health News*, New York, July 11, 1938.) At the end of July 1938 a majority of over 100 requests for federal PWA aid were for new sewer systems and sewage treatment plants, involving an estimated expenditure of more than $35,000,000. Fifteen new treatment plants along the Hudson River are included. Nearly $11,000,000 will be required for the Bowery Bay and Jamaica plants for New York City.

The changing viewpoint of engineers and of the public generally is an important factor in controlling water pollution in New York State and in the nation as a whole. In 1889, when the Chicago Sanitary District was created, disposal of the Chicago sewage and industrial wastes by dilution in Lake Michigan water diverted through the newly constructed Chicago Drainage Canal was adopted as the logical and best way of disposing of the wastes. In 1924 new and improved methods of treating wastes, and a changed public viewpoint, led a board of twenty-eight engineers to recommend to Chicago the construction of seven major and a number of minor treatment plants at an estimated cost of $125,000,000. During the past two sessions of Congress, Chambers of Commerce, technical societies, luncheon and service clubs, fish and game clubs, and various other organizations of men and women united in urging their congressmen to favor passage of the Vinson-Lonergan and the Barkley-Vinson bills. At present, citizens in all walks of life are taking an interest in the matter.

Much research and study, however, will be necessary before the pollution problem is solved. Trade wastes are continually changing in character, new industries are producing new wastes, practicable methods of treating many wastes are at present unknown, and the effect of various wastes upon the plant and animal life of fresh and tidal waters has not been determined.

"A consummation devoutly to be wished" is the provision of funds for investigation and research in the field of trade waste disposal. It is to be hoped that the provisions of the defunct Barkley-Vinson Bill will be incorporated in a future law.

CHARLES L. WALKER, M. Am. Soc. C.E.
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Initial Investigations of Hydroelectric Plants

TO THE EDITOR: Mr. Larned's article on "Initial Investigations and Economical Planning of Hydroelectric Plants," in the December issue, constitutes an up-to-date, authoritative discussion which can be read with profit by any engineer responsible for the planning of power plants to meet anticipated growth of load. There will be little disagreement with the conclusions of his article since they correctly present the facts established by years of experience in planning for load growth on many important utility systems in this country.

Mr. Larned confines his discussion to the planning of a hydro plant to meet the growth of load of an electric utility system. As a matter of fact, such plants constitute only a small proportion of the hydro capacity developed during the last decade, or of that likely to be constructed in the near future. Much of the nation's undeveloped water power is concentrated on great river systems, such as the Columbia, Colorado, Tennessee, or St. Lawrence. While some few utility systems may be financially able to undertake such projects as Boulder or Shasta and have a sufficiently rapid rate of growth of load to utilize the power, they have not, for various reasons, been able to proceed with construction. Political opposition, the difficulty of obtaining water rights, the multiplicity of state and federal approvals required, and the problem of reconciling conflicting states' rights have proved too difficult for any private organization to overcome.

Such projects may be classified as multi-purpose and may involve a number of uses, including navigation, irrigation, flood control, and domestic water supply, as well as hydroelectric power, which is incidental to the extent that the other purposes must first be served. The power-planning problems in connection with such developments are very different in character from those discussed by Mr. Larned. On a drainage area which is measured in thousands of square miles and a stream having numerous large tributaries, this problem becomes very complex. The formulation of a comprehensive regional plan for the best utilization of the water resources of the entire stream is a first consideration. It is necessary to give primary consideration to the basic requirements that must first be served, such as flood control, irrigation, navigation, and domestic water supply. Power development is obviously not a basic requirement, but becomes incidental even though it may carry the major cost of the multi-purpose project. If navigation is to be developed, there must be created a continuous series of pools of navigable depth, which to a certain extent fixes the location of dams. If flood control is necessary or desirable, the storage capacity to be developed and held available for floods must be determined. It will be possible to utilize some

but not all of the flood storage capacity to impound water for low-water regulation for power after danger of floods has passed. Irrigation requires the storage of high flows and release during periods of low flow. This regulation to a certain extent coincides with that desired for power, although there is some conflict, particularly in the late fall when power demands are high, natural stream flow low, and irrigation requirements practically nil.

The height of a dam may be increased to provide a greater amount of storage than is required for these basic purposes, to develop head, and to provide storage for generation of power. The problem then arises as to how high the dam should be built, what hydro capacity should be installed, and how the project should be operated to hold the net cost of the project to a minimum. Frequently the exact market for the power has not been determined, and it becomes necessary to study the load requirements of the adjoining region and investigate many different possibilities for interconnections to neighboring systems.

From this brief enumeration of a few of the problems which must be considered, it is evident that the planning of such great multi-purpose projects assumes formidable proportions and is worthy of the best efforts of the engineering profession.

ROBERT A. MONROE, M. Am. Soc. C.E.
Assistant Chief Water Control Planning Engineer, Tennessee Valley Authority
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TO THE EDITOR: In his article on "Initial Investigations and Economical Planning of Hydroelectric Plants," in the December issue, Mr. Larned has outlined the essentials to be kept in mind in reporting and recommending the best procedure for the extension of power facilities in a system, and has emphasized the necessity of sound and thorough engineering investigation as a basis for such a report.

Discussion of a few phases of the subject may add something of value. To obtain an additional kilowatt of steam capacity requires all elements of the plant and an expenditure of about $100 per kw. To obtain an added kilowatt of hydro capacity requires no addition to dam and reservoir, and often but little to waterway. The added cost is practically that of the power house and equipment. The latter vary in cost with head, from about $40 per kw for high heads to $90 for low heads. There is usually therefore a material saving in cost of incremental hydro capacity as compared to steam. The same would also be true in the case of Diesel power.

The use of hydro power to carry peak capacity depends upon the availability of pondage at the hydro plant. This enables the use of water for power generation during the period of higher load demand, while at off-peak times water may be ponded. In this way a 24-hour average available hydro capacity may be stepped up to several times that capacity for peak use. The consideration of adequate pondage at a hydro plant in a power system is therefore of primary importance, and should be kept well in mind in hydro plant layout.

Mr. Larned suggests that in some cases a dam and reservoir might be built and used, at first for storage, later supplementing this use by one or more hydro units, for which intakes are provided in the initial construction. To be economical, storage must have sufficient head through which the stored water can be used. The limit in expenditure that is usually feasible varies with this head, as well as with the amount of storage developed per square mile of drainage area.

TABLE I. LIMITING COSTS OF STORAGE

Storage Acre Ft per Sq Mile	Limiting Cost of Storage per Acre Ft for Heads of			
	100 Ft	300 Ft	500 Ft	1,000 Ft
100	$6.00	$18.00	$30.00	$45.00
200	5.50	17.50	29.00	59.00
300	5.00	15.00	26.00	52.00
500	3.50	11.00	17.00	36.00

Table I is based upon a study using storage-flow relations for Vermont rivers and an assumed increase in value of primary (95 per cent) power over secondary of 0.5 cent per kwhr. While any given storage project should be studied in detail by itself, this table gives a good picture of limitations in economic cost of storage under ordinary conditions.

The cost of storage reservoirs usually varies from about $10 per acre ft or less for the best sites to $60 per acre ft or more for the more expensive sites. Hence, unless 300 ft or more of head is available for use of stored waters, the cost of development of storage is likely to be too great except under favorable site conditions.

H. K. BARROWS, M. Am. Soc. C.E.
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Retaining Wall Footings

TO THE EDITOR: The argument of Mr. Eckles' article on "Design of Retaining Wall Footings," in the November issue of CIVIL ENGINEERING, is that excessively high bond stresses occur under the wall or stem, due to the very large shears that accompany the reversal of bending moments in that region.

The stress conditions which he describes at considerable length may be concisely shown by the accompanying Fig. 1. In this diagram the free-body with forces acting is shown in (*a*), the shear diagram in (*b*), the moment diagram in (*c*), and a study of stresses in reinforcement in (*d*). A plane of contraflexure occurs under the wall, as brought out by Mr. Eckles. Exception should be taken, however, to his statement that, "It would be impossible for tension due to moment to pass the plane of contraflexure because all stress there except shear must be zero..." The reinforcement always extends well beyond the plane of contraflexure. As indicated in my Fig. 1(*d*), the tensile stress in the cantilever portions probably follows the variation in bending moment, and is maximum at points of maximum moment, *m* and *p*. It evidently diminishes to zero at the ends *n* and *q*. While the actual variation is not known, it certainly does not become zero at the plane of contraflexure, which is essentially Mr. Eckles' assumption.

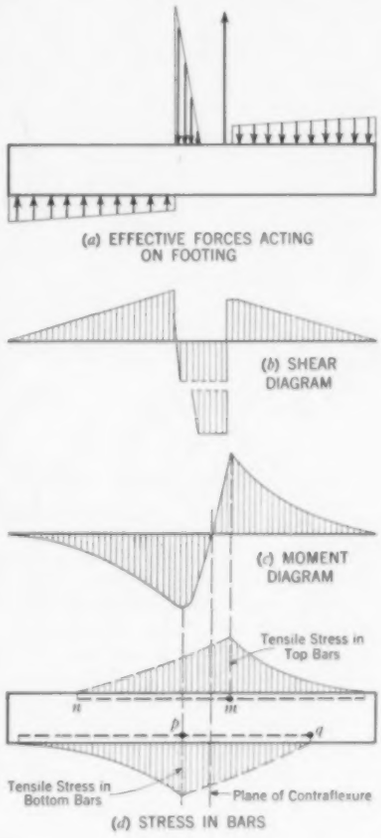

FIG. 1

The condition of zero moment at plane of contraflexure is satisfied if the total stress on the tension side, and on the compression side, is zero. This merely requires that bar tension across plane of contraflexure be balanced by compression in concrete surrounding the bar, such as occurs in "pull-out" bond tests.

Bond stress is measured by the rate of change of tensile stress in the bar. If, as Mr. Eckles assumes, the tensile stress varies from maximum to zero in the short distances between maximum and zero bending moments, the bond stresses would indeed be cause for alarm. If, however, as seems much more probable, the tension gradually decreases to zero at the end of the bar, the resulting bond stress becomes reasonable. It is difficult to see how bond failure can start at intermediate points along a bar, but must start at the end. On this account anchorage, by hooks or otherwise, still further insures against bond stress failure.

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Economic Factors of Hydro Plant Design

TO THE EDITOR: In his analysis of "Hydro Power Plant Space and Cost Trends," in the January issue, Mr. Gerdes has discarded the usual engineer's measuring stick, such as cubic yards, tons, etc., and substituted a unit of "installed kilowatt" as the real measure of value or economy of the plant. The kilowatt unit has often been used as a rough overall cost measure of a plant, but when used in detail as a measure of cost and efficiency of design it leads to rather conflicting results which may confuse the designing engineer.

In his Fig. 2 (*a*) Mr. Gerdes endeavors to show the efficiency of design by giving the relation of cubic yards of concrete per kilowatt for different plants.

In Fig. 2 (*b*) he endeavors to show the efficiency of construction by giving the costs per kilowatt of substructure concrete for these same plants. Listing from these data three dam sites all having approximately the same head, we have

	CONOWINGO	WILSON	BAGNELL
Fig. 2(*a*)—cubic yards per kw . . .	0.57	0.92	1.14
Fig. 2(*b*)—dollars per kw	25.00	22.50	19.00

Using kilowatt as a measuring stick (Fig. 2*a*), Bagnell could be criticized for inefficiency of design because it has twice as much concrete per kilowatt as Conowingo, and (Fig. 2*b*) Bagnell could be commended for its construction efficiency because the cost per kilowatt is low. As a matter of fact, the same company designed and constructed both of these projects with the same engineering and construction personnel, and since Bagnell was constructed after Conowingo it can hardly be said that the company lacked experience in design.

If from Fig. 2 (*c*) we select at random the cost per cubic foot of three superstructures, we arrive at the following: Ariel, 56 cents; Bagnell, 70 cents; and Wallenpaupack, 71 cents.

Here is a differential of approximately 30 per cent between low- and high-unit costs, which conceivably falls within a logical spread for cubic-foot costs. It is interesting to note how this spread changes to more than 500 per cent for the same three stations when the kilowatt is used as a measuring stick for both volume and unit costs.

	ARIEL	BAGNELL	WALLENPAUPACK
Fig. 2(*c*)—dollars per kw	1.30	5.25	7.00
Fig. 2(*d*)—cubic foot per kw	2.3	7.5	10.0

Such a wide divergence can hardly be due to relative efficiency, but rather tends to prove that the unit of cost or volume "per kilowatt installed" as a measuring stick of engineering inefficiency and construction efficiency is not a sound basis of reasoning.

Mr. Gerdes' article is extremely interesting, but there is danger in the possibility that students or engineers with little or no experience may use such data as a short-cut for their problems. Analysis of this kind should not be used in lieu of keen engineering analysis of the problem in hand. Cubic feet of building and cubic yards of substructure concrete should be determined by the factors of maintenance and loads to be supported, regardless of their relationship to the kilowatt. The advancement of the art may throw out any previous conclusions based on using the kilowatt as a measuring stick. Designs and estimates of every project should give consideration to the factors of conditions on the site, wage rates, freight rates, etc. For these factors there are no short-cuts based on kilowatt installed on other projects.

The study represents a great deal of arduous work, but the results do not assist in the endeavor to establish more accurate cost data for estimating nor do they weight the many natural conditions that may exist between the older installation and the new design.

WILLIAM F. JENRICK, Assoc. M. Am. Soc. C.E.
Boston, Mass.

The Analysis of Continuous Structures

DEAR SIR: The writer noted in the December issue the article by Prof. Odd Albert entitled "The Fixed-Point Theory for Continuous Beams with Elastic Supports," and, due to interest in the analysis of continuous structures, checked the moments given for Fig. 5, which the author had solved numerically. It was found that Professor Albert's values differ by varying amounts up to 22 per cent from those computed by the writer.

The method set forth by Professor Albert involves the use of drafting instruments. The nature of the diagram is such that the scaled distances, which are a necessary part of the solution, may be subject to inaccuracy unless the drawings are made to a large scale and in a painstaking manner. This tires the computer and is time-consuming. Also the method is deficient in automatic checks to guard against errors.

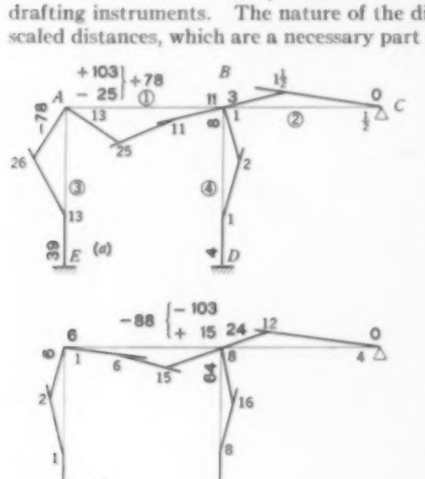

FIG. 1. SOLVING FOR MOMENTS IN CONTINUOUS FRAME
Boldface Numerals Indicate Moments; Small Numerals, Angles

The following solution of the example presented by Professor Albert in his Fig. 5 uses fewer and simpler flexural relationships, dispenses with scale drawings, and provides an automatic check against errors. It can also be performed much more expeditiously.

In Fig. 1(*a*), herewith, is shown the effect of a trial fixed end moment of 103 applied to member *AB* at *A*, 103 being the moment which produces a unit rotation at joint *B*. In making the computation (which is fully explained in the writer's paper in the January 1938 PROCEEDINGS of the Society, page 123), the joint rotation of unity at joint *B* is assumed first and the moment of 103 which produces it is the last item computed. Everything on this figure can be computed in less than three minutes, using mental arithmetic only.

Similarly, Fig. 1(*b*) represents a computation which begins with a unit rotation at *A* and ends with the fixed end moment of 103 at *B* which produces it. It is not necessary to check any of the computations on these diagrams for errors, as the fact that the fixed end moment in each case was found by the detailed computation to be 103 proves, by Maxwell's theorem of reciprocal deflections, that the work was correctly computed.

TABLE I. MOMENTS IN STRUCTURE SHOWN IN FIG. 1

ITEM	M_A	M_{BA}	M_{BC}	M_{BD}	M_D	M_E
Fig. 1(*a*)*	3,550	501	137	364	182	1,775
Fig. 1(*b*)*	273	4,005	1,092	2,913	1,456	136
Total	3,823	4,506	1,229	3,277	1,638	1,911
Values as Computed from Fixed-point Diagrams	3,500	4,200	1,500	2,700	1,350	1,750

* Moments from this figure, multiplied by the ratio 4,687.5/103

The actual fixed end moments due to the loading of 1,000 lb per lin ft on span *AB* are 4,687.5 ft-lb. Multiplying the moments on the figures by the ratio of 4,687.5 to 103 and combining as in Table I gives the true moments in the structure. On the basis of the common theory of flexure with shear neglected these are correct to the last figure.

With Fig. 1, the effect of any fixed end moment due to any loading in either or both spans *AB* and *BC* can also be tabulated from a single slide-rule setting without additions or alterations to the figures.

R. W. STEWART, M. Am. Soc. C.E.
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This for a time ended his contribution to engineering in the

Essentially, Colonel Sawyer is a home man, loyal and devoted

SOCIETY AFFAIRS

Official and Semi-Official

Donald H. Sawyer—Incoming President

MANY NOTED engineers have been identified, often times throughout their entire lives, with a certain locality. It characterizes them distinctly and they seem to acquire some of the qualities that are characteristic of that section. But if one were to ask what section of the country can claim Donald Hubbard Sawyer, the question would be difficult to answer. Although he was brought up in Illinois and there engaged in early engineering work, in his maturity he had extensive experience in the Puget Sound section of the Far West; and finally, when the War took him away from this locality he went to the Atlantic Coast, where he has resided ever since. In a geographical sense, therefore, he is a man of parts; likewise, in character and ability.

DONALD H. SAWYER
President American Society of Civil Engineers

While such widespread experience is an asset, it does not necessarily point to Society preferment. The question therefore arises as to how such a man came to be singled out for the Presidency. The answer is not difficult to find—in fact, the choice was a most natural one. At the meetings of the Board of Direction, his fellow members soon found that they had a practical thinker in their midst, with a background of knowledge gained through experience in every section of the country. They learned that no sectionalism or private antipathy entered into his considerations of matters of policy or of persons. In debate he is clear, humorous, and good-natured, giving to his fellows that same consideration which he desires to receive from them. He has applied himself sedulously to the affairs of the Society; he has given a full measure of service. It was these and other sterling qualities that were recognized by his nomination and subsequent election as President for 1939.

His paternal forebears came to America from England, and settled in the New England states. He belongs to the ninth generation of Sawyers in this country. The three generations immediately preceding him were born in Chester, Vt.

His grandfather, having a pioneer spirit, moved to the West. His father settled in Mt. Pulaski, Ill., where he met and married Phoebe Content Hubbard. When Donald Sawyer was six years old his father moved the family to Oak Park, a suburb of Chicago. There he spent his boyhood; it was "home" to him until he went forth to make his way in the engineering world.

It seems trite to observe that as a boy he delivered the local newspapers; nevertheless such is the fact in his case as in that of many other men who became prominent in later life. About that same time he attended the First Baptist Church of Oak Park and was sufficiently enterprising to secure the position of pipe organ pumper, for which he received the munificent sum of twenty-five cents a Sunday. Legend relates that his family learned of this emolument and caused the twenty-five cents to be put in the collection plate the following Sunday. Father Sawyer, passing the plate, never forgot to present it through the curtain, on the other side of which our president was industriously pumping away. This experience is said to have had one recompense—it is reported that Colonel Sawyer is about to become president of the Ancient Order of Pipe Organ Pumpers.

In spite of such early discouragement, he has always been a regular church attendant. He has frequently served on official church boards and has given unsparingly of his time, effort, and funds to the furtherance of the cause of religion. He is now chairman of the trustees of the Calvary Baptist Church in Washington, D.C.

Another of D. H. Sawyer's early experiences had an important bearing on his later life. One day, while playing in the streets of Oak Park, he stopped to watch a surveying party and became fascinated by the transit. His wonder as to how the man looking through the telescope could find his answer from the distant rod led him to become interested in the profession. This attraction was further stimulated by his first engineering job, a year of work under the valued tutelage of John W. Alvord, Hon. M. Am. Soc. C.E. He followed up this auspicious beginning by entering the engineering course at the University of Illinois in 1898.

The story is told that, when he arrived at Champaign, he was a little doubtful as to how he should proceed, but his doubt resolved itself into a decision to go to the very top. So he repaired, according to the popular account, to the residence of the president of the university, rang the doorbell, and advised the maid of the opportunity he was presenting to the university. It was with some difficulty that he was shown the path to the office of the registrar. At the university he soon became outstanding in his class and because of his faculty of mingling readily wherever a group gathered, he immediately interested himself in student activities. Perhaps no other member of his class was as well known, a fact that has stood him in good stead in later years. This attribute has led him to the first place in Society leadership.

After graduating from the university in 1902, he filled brief engineering engagements in the East, but the following year he was back in Illinois. First he was city engineer of Paris, and then chief engineer of the Illinois Traction Company, for which he built about 300 miles of interurban railways throughout the state.

Growing in popularity year by year, this event has deservedly

On Friday morning a special train carried an enthusiastic crowd

This for a time ended his contribution to engineering in the Middle West. In 1910 he succumbed to the lure of the Pacific country, and following Horace Greeley's advice, went to the Northwest, where he became a member of the firm of Sawyer Brothers, with offices in Spokane and Seattle, Wash. This firm specialized in irrigation and power plants, in addition to its general practice in municipal engineering. Both design and construction engaged his attention until the War rudely interrupted this interesting work.

Shortly after America entered the conflict he was summoned to Washington and commissioned a Major in the Army. In accepting this appointment he was following in the footsteps of his father, who had served with distinction throughout the Civil War. There was this difference, however, that Donald Sawyer was not a soldier in a military sense. Although his service was exemplary, as attested by his rapid promotion in military rank through the grades of major, lieutenant colonel, and colonel, and though he is now a colonel in the Officer's Reserve Corps (Engineers) there is nothing of the professional soldier about him—military discipline or outlook find no lodgment in his mind.

Following his Army experience, he was for a number of years in heavy construction work with James Stewart and Company. Then ensued seven years of most valuable experience as secretary of the Associated General Contractors of America. Colonel Sawyer entered government service in 1931, and was for a number of years Director of the Federal Employment Stabilization Board. He has been singled out for advancement until he is now special assistant to the Director of Procurement and Chief of the Section of Space Control in the U. S. Treasury Department. His work has also included the presidency of the U. S. Housing Corporation.

Essentially, Colonel Sawyer is a home man, loyal and devoted to his family. Upon the death of his father, he insisted that his mother should live with him. His attention to her became one of the greatest satisfactions of his life; no man could have been more devoted in word and deed. She remained with him until her death. In 1929 he married Elizabeth Osborn Merriam. The couple is one of the most popular in current Society circles. Their frequent attendance at Society meetings has widened their already large circle of friends.

His social accomplishments play no small part in Colonel Sawyer's popularity. He is generous, lovable, and humorous. And he possesses considerable facility as a toastmaster or chairman of a meeting. He speaks readily and clearly and so conducts the proceedings that all thoroughly enjoy themselves and feel entirely at home. When there is danger that a meeting will become dull, he can introduce a pat story, which never fails to put new life into the gathering.

Although not what is known as a club man, he maintains membership in the Cosmos, and the Army and Navy clubs in Washington. In addition, he is a member of Phi Gamma Delta Fraternity. He finds diversion in golf, contract bridge, and the movies.

In addition to his other qualifications, Colonel Sawyer has had wide experience in Society affairs. Here also his advancement has been continuous. He was a Director from 1926 to 1928, and a Vice-President in 1935–1936. He is familiar with Society matters; he is acquainted with Society members; and he is fired with a deep desire to further serve his chosen profession. Many Local Sections and Society members during the year will find it a privilege to share his grasp of organization matters and to come under the spell of his warm personality.

Features of the Eighty-Sixth Annual Meeting

LAST year's record-breaking Annual Meeting registration of 2,137 was exceeded by more than 10 per cent at the 1939 Annual Meeting, which convened in New York on Wednesday, January 18. In all, 2,380 Society members, guests, and members of Student Chapters participated in one or more of the events on the four-day program.

In accordance with time-honored custom, the program of the opening session on Wednesday morning centered about the conferring of Honorary Memberships and prizes. Four of the five newly elected Honorary Members received their certificates in person—C. Frank Allen, Anson Marston, Arthur S. Tuttle, and Frank E. Weymouth. The fifth—Edward E. Wall—being unable to attend, was represented by F. G. Jonah, M. Am. Soc. C.E.

The five winners of Society prizes were all present to receive their awards: Hunter Rouse, the Norman Medal; E. C. Hartmann, the J. James R. Croes Medal; Leon S. Moisseiff, the James Laurie Prize; Charles M. Noble, the Arthur M. Wellington Prize; and Douglas M. Stewart, the Collingwood Prize for Juniors.

This year another event of unusual significance was also on the program. John F. Stevens, Past-President and Honorary Member of the Society, received in absentia the Hoover Medal, a joint award of the four Founder Societies, which has been made but three times since its establishment in 1930. The presentation was made by Gano Dunn, M. Am. Soc. C.E., after a eulogy by Ralph Budd, M. Am. Soc. C.E., and Mr. Stevens was represented by his son, Donald F. Stevens, also a member of the Society.

Reports of the Board, the Secretary, and the Treasurer, and a brief business meeting were also a part of the morning session, which was brought to a close with the introduction of the President-Elect and the other new officers.

Luncheon served in the Engineering Societies building was followed by the "General Meeting," at which a comprehensive symposium was presented on "Improvement of the Social, Economic, and Professional Status of the Civil Engineering Profession." The program was designed to bring before the members what other professions have done along this line, and accordingly there were speeches representing law, architecture, and medicine as well as engineering. The formal papers were followed by extensive discussion, both formal and informal.

During the general session, students gathered on another floor for the Conference of Student Chapters. Aside from three brief addresses by Society members, the entire program consisted of discussion by the students themselves. The topics under consideration were "The Young Engineer in Government Employ" and "The Young Engineer in Private Employ."

The formal dinner dance—headline social event of the Annual Meeting—was held on Wednesday evening at the Waldorf-Astoria. A reception for the incoming President and the Honorary Members was, as usual, a part of the program.

Thursday the daylight hours were well occupied with sessions of six Technical Divisions. Zoning problems of special local interest and others of national scope made up the City Planning Division's program. The symposium of the Engineering Economics Division on "Public Works and Unemployment Relief as Permanent Public Problems" attracted much interest and the papers were followed by animated discussion. (This symposium appears in the current issue, page 80 et seq.). At the session of the Highway Division, one paper dealt with New York City thoroughfares and another with flood and hurricane effects on Connecticut Highways. Hurricane effects were also featured on the Waterways Division program, which included two papers on the behavior of beach protection structures during the 1938 disaster. A technical paper on sediment transportation concluded the session.

Not content with single sessions, the Structural Division and the Sanitary Engineering Division met both morning and afternoon. In each case the morning session was given over to progress reports of Division committees. In the afternoon the sanitary engineers heard papers on milk sanitation and activated sludge practice, while the structural group devoted its full time to a comprehensive paper on tension tests of large riveted joints.

Mention should be made of the many luncheons and dinners held in connection with the Society Meeting by college engineering groups on Thursday and Friday. Get-together luncheons on Thursday were held by the Chi Epsilon Honorary Civil Engineering Fraternity and by the M.I.T. Alumni. In the evening dinners were scheduled by engineering alumni from Brown University, Cornell, Iowa State College, Lafayette College, Lehigh University, Rutgers University, Syracuse University, and the Universities of Illinois, Michigan, and Pennsylvania. Similar gatherings on Friday included the Columbia Engineers dinner, the Harvard-Yale-Princeton Annual Huddle, the New York University Annual Alumni Reunion Dinner, and the Thayer Society of Engineers of Dartmouth College dinner. On Saturday the Clarkson College Alumni scheduled a series of events, including a dinner.

At the Hotel Astor on Thursday evening, members and their guests packed the main ballroom to capacity for the annual Smoker.

Life Members Receive Certificates

membership. Otherwise I would have continued to pay my dues

Growing in popularity year by year, this event has deservedly come to be in many ways the climax of the Annual Meeting. With business and technical sessions over, and with formality dispensed with, members of all ages find there an ideal opportunity for renewing old friendships and making new ones, swapping stories, and settling affairs of state of all degrees of importance. In the early part of the evening they find also the best of the season's entertainment. This year Capt. John D. Craig, explorer and deep-sea diver, who thrilled his listeners last year with accounts of adventure on the bottom of the sea, returned with colored, under-water moving pictures of his recent exploits on Silver Shoals and off the coast of Lower California.

Special entertainment was provided for the ladies on Thursday afternoon in the form of a fashion show and tea, and in the evening there was a bridge party at the Engineering Woman's Club. Quite a number of the women also took advantage of the opportunity to hear the lecture by Captain Craig, special boxes having been reserved for them at the Smoker. In addition to these scheduled events, there were many informal gatherings arranged by the Ladies' Committee.

On Friday morning a special train carried an enthusiastic crowd of excursionists to Allentown, Pa., for an inspection trip through the extensive plant of the Mack Manufacturing Company. The Allentown works produce hundreds of different chassis and body parts, and there also the assembly and finishing of complete vehicles—buses, fire apparatus, and trucks of all sizes—takes place. The visitors had an opportunity to see practically every phase of assembly and to inspect the auxiliary services as well, before returning to New York in the early evening.

Saturday morning was given over to inspection trips in New York City. For the second successive year, the Sixth Avenue subway construction work, the Queens Midtown Tunnel, and the World's Fair site attracted large and interested groups. Other parties visited the U. S. Navy Yard, the Lincoln Tunnel, and the Red Hook Housing Project.

With these trips the Eighty-Sixth Annual Meeting came to a close. Generous credit for its success should go to the various committees who arranged the multitudinous details. Although they stood in the background, their work made itself felt in the smooth running of the various events, both technical and social.

Highlights of Society Progress in 1938

Extracts from Annual Report of Board of Direction for Year 1938; Full Report to Appear in 1939 Year Book

NINETEEN THIRTY-EIGHT appears to have been a year of continued progress for the American Society of Civil Engineers. In the 86 years since that first group of 12 men gathered on November 5, 1852, to form an association, the Society has increased to nearly 15,800 members. The Society's fundamental objective of spreading technical information has never been maintained on a higher plane. Today the Society is a very complex organization functioning through its membership in many directions.

* * * *

The year 1938 closes with the largest membership ever recorded —15,794. That, in general, the total income of civil engineers in 1938 was materially less than in 1929 or 1930 is unquestioned. It is in the face of that fact that the continued growth in membership is the more notable.

Again this year the growth is attributable chiefly to the admission of young men. On December 31, 1938, those in the Junior grade constituted 24 per cent of the total membership. The problem involved in unionization is a matter touching them practically in these days, and it has been, and should be, the continued and intensified duty of the Society to render them guidance and practical help in their appraisal of this new situation.

* * * *

There are at present 63 Local Sections. The Mohawk-Hudson Section and the Wyoming Section were approved by the Board of Direction on April 18, 1938.

* * * *

There are at present 118 Student Chapters, four new ones having been added during 1938—at the University of Detroit; University of Santa Clara; Speed Scientific School of the University of Louisville; and The Citadel, South Carolina.

* * * *

Responsibility should properly be laid upon the Local Sections of the Society for effective action leading to local improvements in the economic status of civil engineers. Problems relating to the welfare of civil engineers arise locally, and with many variations, and can be settled most effectively through local agencies such as the Local Sections of the Society.

To the end that Local Sections may become more effective, three distinct measures have been adopted: First, the allocation of all members to some one or another Local Section, and the formation of new Local Sections so that now the country is fully covered by such Sections; second, the granting to Local Sections of a material increase in financial support so that they may adjust themselves to the solution of these local problems; and third, an intensification of effort to so inform the public of the work of the engineer that the profession may be esteemed more generally and more highly for the part it plays in this civilization.

In this past year special appointments have been made in 43 Local Sections, of individuals or of committees, to develop local publicity for the civil engineer. To assist this program a staff member, with journalistic training, was assigned to prepare a monthly bulletin of suggestions as to releases of information specially directed toward local newspapers. Also, a director of publicity has been in attendance at all Society meetings to take immediate advantage of publicity opportunities; and between meetings he has prepared numerous press releases of a national character.

* * * *

That PROCEEDINGS constitutes a forum for discussion of technical character is evidenced by the fact that for each page of new material there is now the necessity to count upon an additional subsequent page of discussion and author's closure. This shows even greater interest in technical matter than hitherto.

A new method of reporting Board meetings in CIVIL ENGINEERING has been inaugurated. The Secretary's Abstract, now discontinued, was a brief listing of all actions taken, with only occasional explanations. Now the background out of which some of the Board's actions occur is the general basis for treatment, the objective being to apprise the membership generally of the methods by which the Board works and takes action on some of its problems.

This year has seen the largest volume of regular Society publications, distributed, incidentally, at the smallest cost of production.

* * * *

Particular study has been given the Technical Divisions this year, and by a series of By-Law changes already accomplished and in process it is expected that a greater degree of effectiveness will be attained. The Committee on Research has been abolished and those committees which formerly functioned through it are now to function under some one or another of the Divisions. A Hydraulics Division was founded and to it have been assigned several of the former research committees.

* * * *

Of all the Society's numerous working units, designed to improve the status of the engineer, the newly formed Committee on Professional Objectives has by far the broadest scope. Many functions have been assigned to this committee, for study or for aggressive action, all leading steadily toward a greater recognition of the value of civil engineers to the community.

* * * *

As has been true for several years, the Society has no debts of any kind. Operating expenses exceeded operating receipts in 1938 by about $12,000, after allocation of approximately 1 per cent of income to the reserve designated as the "57th Street Property Fund."

* * * *

The attendance at the Reading Room during the year was 2,391.

Two hundred and sixty-four periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and several daily newspapers

Final Ballot on Society Officers

Proceedings of Water Conservation

Life Members Receive Certificates

ON JANUARY 1, 1939, more members of the Society became exempt from dues and joined the ranks of the Life Members. This is in accordance with the constitutional provision applying to those who are 70 years of age and have paid dues as Corporate Members for 25 years, and to those less than 70 who have paid dues for 35 years. The list of the 150 thus honored appears below. Four additional members eligible for this honor—Howell Tracy Fisher, James Noble Hatch, Henry Gorton Opdycke, and Joseph Warren Silliman, died recently.

As usual, the letters notifying members of their exemption brought many interesting replies. One recipient wrote, "While this might be considered by some as a sort of consolation prize for approaching old age, I, however, greatly appreciate the honor." Another, also writing in a humorous vein, says, "I wish to thank you for your diligence in discovering that I was entitled to life membership. Otherwise I would have continued to pay my dues until the final curtain." He adds, "Although I have been retired from practice for a number of years now, my heart is still with the purposes and activities of the Society."

Many of the members express similar appreciation of the honor. Typical of these expressions is a letter from England which states, "I very much appreciate your kindness and that of your Board for making me a Life Member of the Society, an honor which I esteem." Another member writes, ". . . my hearty thanks for the diploma, which I shall frame and hang in my office." Still another, ". . . believe me that I always have and always will consider it a great honor to be a member of the Society, and will be glad at all times to do all I can to support it and further its aims."

Many of the Local Sections make a point of presenting the certificates at their meetings, and a number of these occasions have been recorded in CIVIL ENGINEERING. The other certificates are mailed to the recipients from Society Headquarters.

MEMBERS BECOMING EXEMPT FROM PAYMENT OF DUES AS OF JANUARY 1, 1939

Abbott, Fred Walter
Adams, Arthur
Aims, Walton Irving
Alderman, Clarence Edson
Allen, Charles Metcalf
Allen, Thomas Warren
Almirall, Raymond Francis
Arey, Ralph Jesse
Armstrong, James Wadsworth
Bamford, William Brokaw
Barnes, Fred Asa
Barnett, John William
Barrows, Harold Kilbreth
Bassett, Robert Jay
Beck, Henry Phillips
Belknap, John Mansfield
Bishop, Hubert Keeney
Bliss, George Henry
Boardman, Harold Sherburne
Booth, George William
Bowen, Sherman Worcester
Bowler, Frank Colburn
Brinsmade, Daniel Edwards
Bromley, Albert Henry
Bugbee, Newton Albert Kendall
Burrowes, Harry Gilbert
Butcher, William Laramy
Caird, James Morton
Callaghan, John
Cameron, John Bobbs
Campion, Horace Thomas
Carroll, Charles Joseph
Chapman, Harry Day
Chase, Charles Perry
Churchill, Percival Mitchell
Clermont, John Baptiste
Cole, Edward Smith
Cole, Herbert Nichols
Corrigan, George Washington
Craig, Philip Insley
Crider, James Leland
Cummings, Noah
Danforth, Richard Eugene
Davis, James Lyford
Dean, Arthur Warren
Dillard, John Lea
Dixon, De Forest Halsted
Doble, William Ashton
Dougan, James
Dunn, Herbert Luther
Fairchild, Samuel Edwards, Jr.
Farnum, Loring Nelson
Ferguson, James Easton
Fitch, Howard Augustus
Forgie, James
Fuller, Carl Hamilton
Fyfe, James Lincoln
Galbreath, William Otto
Gayler, Ernest Rotteck
Gillette, Halbert Powers
Gove, William Granville
Gow, Charles Rice
Green, Frederick May
Gregory, Luther Elwood
Griffin, Arthur James
Grover, Nathan Clifford
Hammond, Alonzo John
Harris, George Brodhead
Hartmann, Andrew Philip
Hawxhurst, Robert, Jr.
Haydon, George Condit
Higgins, Herman Keene
Hiller, John Augustus
Hodgman, Harry
Holdredge, Henry Atkinson
Horton, George Terry
Horton, Robert Elmer
Hoyt, John Clayton
Jacobs, Robert Hyde
Joachimson, Martin
Johnston, Clarence Thomas
Jonas, Henry F.
Kelley, Joseph Grant
Kelly, William
Kerry, John George Gale
Kieffer, Stephen Ephraim
Klossoski, Theodore Julius
Knighton, John Albert
Lasley, Charles Orton
Leffler, Burton Rutherford
Lewis, Luther Hammond
Lewis, Ransome Tedrowe
Livingston, Archibald Rogers
Lovett, George Frederick
Lucas, George Latimore
Lupfer, Edward Payson
Lyman, Richard Roswell
Macomb, John de Navarre
McCulloch, Robert Austen
McCurdy, Harry Sherwood Royden
McKay, Hood
Menden, William Stephen
Mershon, Ralph Davenport
Middlebrook, Charles Trinder
Monahan, John Joseph
Nelson, James Augustus
Newell, Herbert Damon
Nicholson, Frank Lee
Norton, Homer Burdett
Patch, Walter Woodbury
Paterson, Harry Thomas
Perkins, William Warr Cassidy
Pillsbury, George Bigelow
Prouty, Edward Nathan
Quinn, Richard
Raynor, Clarence Webster
Reaburn, De Witt Lee
Reber, Henry Linton
Rich, Edward Dunbar
Richards, Frederick David
Robb, Louis Adams
Sanborn, James Forrest
Schubert, Frederick Celestine
Shattuck, Orville Frank
Shelley, Henry Thomas
Shertzer, Tyrrell Bradbury
Smith, Lloyd Bown
Snow, Jesse Baker
Snyder, Frederic Antes
Spear, Walter Evans
Stevenson, William Freeman
Storrs, John Williams
Strong, James Boorman
Swindells, Joseph Springer
Sylvester, Ira Wallace
Taber, Edward Gray
Taggart, Ralph Cone
Thorley, Ira Otis
Tinker, George Henry
Tucker, Herman Franklin
Wachter, Charles Lucas
Walker, James Wilson Grimes
Wallace, Harold Ulmer
Weedin, Kirby Calhoun
Wells, Lawrence William
White, Frank George
Wild, Herbert Joseph
Woods, Andrew Alfred
Wright, Joseph
Zesiger, Albert William

Spring Meeting to Be in Chattanooga, Tenn., April 19-22

WITH the Annual Meeting a matter of history, April 19–22 is the next important date on the Society's calendar. On those four days the Tennessee Valley Section plays host to the entire membership at the 1939 Spring Meeting.

A technical program of unusually wide scope is planned, the following five Divisions having scheduled one or more sessions each: Construction, Highway, Hydraulics, Surveying and Mapping, and Soil Mechanics and Foundations. In addition, a comprehensive symposium on masonry dams is being arranged by a joint committee of six Divisions, under the auspices of the Power Division.

The local committee in charge of arrangements has been active for some time and promises an attractive schedule of social events and inspection trips. Further details of the Spring Meeting will be published in the March issue of CIVIL ENGINEERING and the final program will appear in the April issue.

Horatio Allen Scholarship Is Awarded

ANNOUNCEMENT is made of the award of the Horatio Allen Scholarship at Columbia University for the year 1938–1939 to W. Proctor Cartwright, of Logan, Utah. Mr. Cartwright received his B.S. in civil engineering from Utah State Agricultural College in June 1938. He matriculated at Columbia University in January.

The Horatio Allen Scholarship was established in honor of Horatio Allen, fifth President of the Society and a member of the class of 1823 at Columbia University. It covers tuition fees to the amount of $380 a year and is open to civil engineering students who can submit credits covering at least the first two years in an accredited engineering school. It may be held by the successful candidate for from one to three years, depending upon the class he enters at the University. His record must be approved by both a committee of the Society and the Dean of the Engineering School at Columbia University.

Final Ballot on Society Officers for 1939

33 West 39th Street
New York, N.Y.
January 11, 1939

To the Eighty-Sixth Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1939 report as follows:

For President		
Donald Hubbard Sawyer	3,251	
Scattering	10	
Blank	9	
	3,270	
For Vice-Presidents		
Zone II:		
Charles Miller Reppert	3,220	
Scattering	3	
Blank	47	
	3,270	
Zone III:		
James Lumsden Ferebee	3,223	
Scattering	17	
Blank	30	
	3,270	
For Directors		
District I (two to be elected):		
Harold Walton Hudson	3,219	
Harold MacLean Lewis	3,222	
Scattering	6	
Blank	93	
Total votes registered	6,540	
Total ballots canvassed	3,270	
District 4:		
Sanford Wales Sawin	3,241	
Scattering	0	
Blank	29	
	3,270	
District 11:		
Charles Tileston Leeds	3,237	
Scattering	4	
Blank	29	
	3,270	
District 14:		
Robert Blemker Brooks	3,236	
Scattering	5	
Blank	29	
	3,270	
District 15:		
Edward Sedley Bres	3,245	
Scattering	0	
Blank	25	
	3,270	
Ballots canvassed		3,270
Ballots withheld from canvass:		
From members in arrears of dues	27	
Without signature	69	
With illegible signatures	3	
Total withheld	99	99
Total number of ballots received		3,369

Respectfully submitted,

RALPH H. MANN, *Chairman*

Clifton W. Bolieau	Bernard Gaber
Albert P. Loriot	Edward Whitney
Charles D. Thomas	Bernard L. Weiner
George R. Latham	Howard Holbrook

Tellers

Proceedings of Water Conservation Conference Available

PROCEEDINGS of the Water Conservation Conference held in Salt Lake City on July 19, 1938, have been prepared in mimeograph form by the Utah Sectional Committee on Conservation of Water. Some 80 copies have already been distributed by the committee, and additional copies are available to other members while the supply lasts, on written request to Society Headquarters.

This conference was called by the Committee on Conservation of Water, of the Irrigation Division, under the auspices of the Utah Section of the Society. It included seven papers, four of which appear in full in the present transcript. They are:

"Objectives and Activities of the Society Committee on Water Conservation," by Harry F. Blaney

"What Has Resulted from Operation of the Utah Underground Water Law of 1935," by B. F. Lofgren

"The L.D.S. Church Security Program in Relation to Water Conservation," by John A. Widtsoe

"Objectives and Activities of the U. S. Geological Survey Looking Toward Water Conservation in Utah," by A. B. Purton

The transcript also contains the formal and informal discussion that followed the presentation of the scheduled topics.

The three conference papers not included in the transcript are scheduled for publication in condensed form in the March and April issues of CIVIL ENGINEERING, and will of course be available in reprint form at nominal cost shortly thereafter. This group comprises:

"Mountain Snowfall Work of the Weather Bureau," by Merrill Bernard

"Conservation of Water Through Recharge of Underground Supply," by A. T. Mitchelson

"Snow Surveying or Mountain Hydrology as a factor in Water Conservation," by George D. Clyde

Colorado and Los Angeles Sections Observe Their Anniversaries

IN DECEMBER two of the older Local Sections—Colorado and Los Angeles—celebrated their anniversaries with especially gala dinner meetings. It was the thirtieth anniversary of the Colorado Section, and the twenty-fifth of the Los Angeles Section.

The Colorado Section combined its celebration, which took place at the New Albany Hotel in Denver on the fifth of December, with its annual Ladies' Night. Two of the six charter members still belonging to the Section were present on this occasion. These were Fred C. Carstarphen and Herbert S. Crocker, Past-President of the Society. It is interesting to note that Mr. Crocker served as first president of the Section. Two of the other charter members—John E. Field and James E. Maloney—sent letters. During dinner a sextette from the Sigma Alpha Iota Musical Sorority entertained.

First on the evening's program was a brief résumé of highlights in the history of the Society from the time of its official organization—in December 1908—to the present. This material was prepared by R. E. Van Liew, who has published an article on the subject (CIVIL ENGINEERING for February 1938). Then Roy C. Gowdy, Vice-President of the Society, presented a certificate of life membership to Charles O. Lasley. This presentation was made in absentia, Mr. Lasley being represented by F. O. Ray.

The premier showing of a colored motion picture entitled "The Romance of Water" came next. This film, which traced the course of the water from high mountain collection systems to storage reservoirs and filtration plants, was enthusiastically received. It was pointed out that Denver probably owes its fine parks and beautiful flowers to the large supply of water available. The film was shown by Harry L. Potts, special engineer for the Denver Municipal Water Works.

An address by Roderick L. Downing, retiring president of the Section, concluded the evening. The new officers of the Section are Paul S. Bailey, president; Roy A. Klein, vice-president; and Ralph N. Tracy, secretary-treasurer.

The Los Angeles Section celebrated its anniversary on the 14th, at the time of its regular annual meeting. The attendance included 22 of the 36 surviving charter members. At dinner these members were seated together directly in front of the speakers' table. After dinner Fred Bowlus, the youngest charter member, introduced each of the others present, and all responded with interesting reminiscences of the early days of the Section. A. M. Rawn, president of the Section, then presented certificates of life membership to three members of the Section. Two others thus honored were unable to be present.

An excellent report of the special committee appointed to study the feasibility and need of establishing an institution for scientific research in engineering seismology was presented by Clarence J. Derrick, chairman of the committee. The committee recommended that the Section advise the Society of the necessity for creating such an institute, and the Section unanimously voted to accept this report.

The scheduled speakers were J. B. Lippincott, charter member of the Section and its first president, and H. A. Van Norman, chief engineer and general manager of the Los Angeles Department of Water. Mr. Lippincott described the accomplishments of some of the old-time California engineers, while Mr. Van Norman discussed the early days of the city water department and the building of the Owens River Aqueduct.

The annual election of officers, held at this time, resulted as follows: H. Macy Jones, president; R. V. Labarre and Julian Hinds, vice-presidents; Ray L. Derby, secretary; and Don H. McCreery, treasurer.

Dr. Riggs Rounds Out Term with Many Visits to Society Groups

MAINTAINING the pace he set for himself during the first half of 1938, Henry Earle Riggs continued his visits to Society groups in all parts of the country throughout the fall and winter months. During his term of office as President, which ended on January 18, he visited a total of 41 Local Sections and 38 Student Chapters, and the records show that his formal and informal addresses on these occasions were heard by more than 3,000 members of the Society and some 2,500 students. These totals are of course in addition to the many hundreds of persons he has met and addressed at the quarterly meetings.

An account in the July 1938 issue listed the visits through June 3, on which date he was with the Toledo Section. In July, just prior to the Annual Convention, he attended an informal dinner sponsored by members in Colorado Springs, and following the Convention made two visits—to the Wyoming Section at Cheyenne, Wyo., and to the Colorado Section at Denver. In August he attended the District 7 Convention at Houghton, Mich.

Following attendance at the Fall Meeting, he made a trip down the Mississippi River with the Mississippi River Commission and visited the Mid-South Section at Vicksburg.

His November itinerary was as follows: Society and Student Chapter members at Ann Arbor; Antioch College Student Chapter; University of Kentucky Student Chapter; Tennessee Valley Section; Student Chapter at the University of Tennessee; Student Chapter at the Missouri School of Mines; Mid-Missouri Section; Student Chapter at the University of Missouri; Kansas City Section; engineering students at Kansas University; a joint meeting of the Kansas Section and the Student Chapters at Kansas State College and Kansas University; St. Louis Section; and a combined meeting of the Detroit Section and the University of Detroit Student Chapter.

On December 5 and 6 he was with Dr. Mead at meetings in Ann Arbor, and from the 9th to the 11th he was in New York attending the meetings of the Executive Committee of the Board of Direction. On December 14 he was back in Ann Arbor, attending a dinner arranged by the University of Michigan Student Chapter and attended by Society Members from Detroit, Toledo, and Ann Arbor. Also in December, he visited the Student Chapter at the Carnegie Institute of Technology; the chapters of the four Founder Societies at the University of West Virginia; the Pittsburgh Section; the Cleveland Section; and the Central Ohio Section.

His January schedule took him to various groups in the South as follows: the Virginia Section at Richmond; the South Carolina Engineering Society and the South Carolina Section; the Student Chapter of The Citadel; and the University of North Carolina Student Chapter, the engineering faculty, and local members at Raleigh, N.C. Dr. Riggs ended his itinerary by speaking to engineering students at the Virginia Military Institute.

Twelve Student Chapters Commended for Outstanding Work

UPON recommendation of the Committee on Student Chapters, the Board of Direction, on January 16, 1939, authorized the President of the Society to send 12 letters of commendation to Student Chapters whose activities and reports for the academic year 1937-1938 have been outstanding. Three such awards are made in each of four regions—the north-central, eastern, southern, and western. The recipients this year, in the above order of regions, are as follows:

Carnegie Institute of Technology
Case School of Applied Science
University of Dayton

Newark College of Engineering
New York University
Thayer School of Civil Engineering (Dartmouth)

University of Arkansas
Tulane University
Virginia Military Institute

Oregon State Agricultural College
Stanford University
Texas Technological College

It is interesting to note that the Tulane Chapter has received this award for the fourth successive year. The Stanford and Dayton Chapters have each received this award for the second successive year. The Chapters at Carnegie and at Virginia Military Institute are receiving it for the third time, and Newark for the second time.

In addition, two letters for conspicuous progress were authorized to the University of California and University of Texas Chapters.

The Committee on Student Chapters is pleased to point out that the selection of three Chapters in each region is an exceedingly difficult job because of the evidence of so much excellent work done by such a large number of the Society's student groups. All sorts of evidence available to the committee is carefully weighed and balanced. It is inevitable that the excellence of annual reports must weigh heavily in arriving at a decision, but the quality of the Chapter's program, promptness and care in correspondence, and other evidences of good organization and good operation are given full consideration.

Details from the annual report of the committee on Student Chapters will be distributed to all Chapters at an early date.

Forecast for February "Proceedings"

THE THEORY OF LIMIT DESIGN

By J. A. Van den Brock, M. Am. Soc. C.E.

An argument for minimizing the importance of the theory of elasticity and designing structures on a basis of ultimate strength.

LATERAL SPILLWAY CHANNELS

By Thomas R. Camp, M. Am. Soc. C.E.

Contains simplified formulas and diagrams for small side-channel spillways of uniform sections such as those used in sewage treatment and water purification plants.

MALARIA CONTROL FOR ENGINEERS

Report of the Joint Committee of the National Malaria Committee of the Southern Medical Association, through its Subcommittee on Engineering, and the Sanitary Engineering Division of the Society.

Designed to correct the condition expressed by the indictment, "In the view of some malaria experts, engineers are now the chief offenders in the causation of preventable malaria in this country."

Washington Award to Daniel W. Mead

DANIEL W. MEAD, Past-President and Honorary Member of the Society, has been chosen as the recipient of the Washington Award for 1939. Presentation of the award, in the form of a bronze plaque, will be made on February 20 at the Drake Hotel in Chicago, at a joint dinner meeting of the Western Society of Engineers and the four Founder Societies, all of which are represented on the award commission. The award was made in recognition of Dr. Mead's "superior contribution to sound theory and good practice and high ethical standards in the creation of engineering works as an engineer and as a teacher."

The Washington Award was founded in 1915 by John W. Alvord, M. Am. Soc. C.E., and is administered by the Western Society of Engineers. It is given annually "as an honor conferred upon a brother engineer by his fellow engineers on account of accomplishments which preeminently promote the happiness, comfort, and well-being of humanity."

Dr. Mead, says the *Bulletin* of the Western Society of Engineers, "has been an outstanding figure in professional, educational, and public service over a long period of years. He has contributed to hydraulic engineering, particularly in the branches of hydroelectric development, irrigation, drainage, and water works. . . .[He] has had a remarkable influence on the thousands of engineering students who have come under his direction in college and also in their later development. His high standard of ethics has been an inspiration to all with whom he has come in contact."

Appointments of Society Representatives

CHARLES GILMAN HYDE, M. Am. Soc. C.E., has accepted an appointment to represent the Society on the Sectional Committee of the American Standards Association on Mimimum Requirements for Plumbing and Standardization of Plumbing Equipment.

DONALD H. SAWYER, President Am. Soc. C.E.; ALONZO J. HAMMOND, Past-President Am. Soc. C.E.; JOHN C. HOYT and CARLTON S. PROCTOR, Members Am. Soc. C.E.; and GEORGE T. SEABURY, Secretary Am. Soc. C.E., are the Society's appointees on the Construction League of the United States.

News of Local Sections

Scheduled Meetings

COLORADO SECTION—Dinner meeting at the University Club on February 13, at 6:30 p.m.

DAYTON SECTION—Luncheon meeting at the Dayton Engineers Club on February 20, at 12:15 p.m.

GEORGIA SECTION—Luncheon meeting at the Atlanta Athletic Club on February 13, at 12:30 p.m.

IOWA SECTION—Evening meeting at the Hotel Fort Des Moines, Des Moines, Iowa, on February 14, at 8:00 p.m.

KANSAS STATE SECTION—Luncheon meeting at the Kansan Hotel, Topeka, on February 10, at 12:30 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on February 8, at 6:15 p.m.

METROPOLITAN SECTION—Joint meeting with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the New York Municipal Engineers, in the Engineering Societies Building on February 15, at 8:00 p.m. (Subject, "New York World's Fair, 1939.")

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on February 2, at 7:00 p.m.

NASHVILLE SECTION—Meeting on Feburary 7.

NEW MEXICO SECTION—All engineers' banquet at the Hotel El Fidel, Albuquerque, on February 17, at 7:00 p.m., held in connection with the Road Conference of the State Highway Department and the University of New Mexico.

PHILADELPHIA SECTION—Social meeting at the Engineers Club on February 18, at 6:15 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the Mayfair Hotel on February 27, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers Club on February 21, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers Club on February 27, at 6:00 p.m.

Recent Activities

CENTRAL ILLINOIS SECTION

Aluminum, particularly the fabrication of structural shapes, was the subject that entertained members of the Central Illinois Section attending the November meeting. This session, which was held at the Abraham Lincoln Hotel in Springfield on the 29th, was a joint activity with the Springfield Engineers Club and the Springfield Chapter of the Illinois Society of Engineers. The combined attendance was well over a hundred. The annual dinner meeting of the Section, held at Bradley Hall in Champaign on December 15, featured a discussion of the application of geological principles in the solution of engineering problems. The speaker presenting this subject was Dr. George E. Ekblaw, geologist with the Illinois State Geological Survey. The annual election of officers was also held at this time, the result being as follows: Whitney C. Huntington, president; Clifford M. Hathaway and Randolph P. Hoelscher, vice-presidents; and Harry P. Evans, secretary-treasurer. There were 28 present.

CENTRAL OHIO SECTION

The annual dinner meeting of the Central Ohio Section took the form of a joint session with the Ohio State University Student Chapter, held on the university campus on December 8. The speakers and guests of honor were President Riggs, Vice-President Gowdy, and Director J. E. Root. All spoke briefly on Society affairs. Daniel W. Mead, Past-President of the Society, was also an honored guest, but did not speak as he had addressed the engineering students at the university earlier in the day. Additional features of interest at the meeting included the presentation of a certificate of life membership to John L. Dillard and the installation of Section officers for 1939. These new officers are Paul M. Holmes, president; R. B. Jennings, first vice-president; and K. B. Woods, secretary-treasurer. The total attendance of 105 included 54 students.

CINCINNATI SECTION

Two meetings of the Cincinnati Section took place in December. On the 5th, about 25 members and guests met at the Cincinnati Engineers Club to hear Maj. Bradley Jones, professor of aeronautical engineering at the University of Cincinnati, give a talk on the development of aircraft for military purposes. His talk was illustrated with lantern slides. Warren W. Parks, president of the Section, then presented certificates of life membership to J. A. Hiller and A. A. Woods. On the 12th there was a luncheon meeting, which was attended by 18. The speakers on this occasion were Vice-President Gowdy and Director Root, who discussed matters of interest to the Section.

CLEVELAND SECTION

At its December dinner meeting the Cleveland Section honored four officials of the Society—President Riggs, Past-President Mead, Vice-President Gowdy, and Director Root. All spoke on different phases of Society activities, and a good-sized crowd was present to hear them. Nearly 200 attended the annual dinner meeting of the Section, which took place on January 9. On this occasion the guest speaker was Dr. Arthur E. Morgan, former chairman of the Board of Directors of the Tennessee Valley Authority. In discussing his subject, "Some Observations on Politics and Business," Dr. Morgan cited the benefits accomplished by justice in the settlement of disputes, whether international or civil. Certificates of life membership were presented to James E. Ferguson, Carl H. Fuller, Burton R. Leffler, Frederick D. Richards, George H. Tinker, and Albert W. Zesiger. The meeting concluded with the election and installation of new officers. These are Frank C. Tolles, president; John H. Anderson, vice-president.

and G. Brooks Earnest, secretary-treasurer. Music during dinner was furnished by the string quartet of the Case School of Applied Science.

DAYTON SECTION

There were 17 present at the annual meeting of the Dayton Section, which took the form of a luncheon held at the Engineers Club on December 19. During a brief business session the following officers were elected for the new year: G. V. Clow, president; J. J. Chamberlain, Jr., first vice-president; J. F. Hale, second vice-president; and C. H. Stephens, secretary-treasurer. The program was devoted to a report of the Local Sections Conference held at the Rochester Meeting of the Society.

DISTRICT OF COLUMBIA

The Junior Forum of the District of Columbia Section reports two meetings. On October 24 there was a session, which included a technical talk by Dr. Edward B. Stephenson, of the Naval Research Laboratories. Dr. Stephenson discussed the subject, "The Use of Sound in Hydrographic Surveying." At the meeting held on December 5 the following new officers were elected for the coming year: T. Ritchie Edmonston, president; Milton Dubin, vice-president; and James H. Carr, Jr., secretary-treasurer. The technical program consisted of a talk on earth construction. This was given by T. A. H. Miller, of the Bureau of Agricultural Engineering, U. S. Department of Agriculture.

FLORIDA SECTION

The proposed new engineering registration law was the principal topic of discussion at the December 16th meeting of the Florida Section. Robert M. Angas, chairman of a committee appointed to study this bill, reported on the subject, and various members presented their opinions. The reports of the nominating and other committees were also heard at this session, and it was announced that Charles J. Carroll had attained the status of life member of the Society.

GEORGIA SECTION

The Georgia Section reports that at its December meeting the following officers were elected for 1939: Walter S. McDonald, president; A. J. Cooper and H. J. Friedman, vice-presidents; and H. O. Robison, secretary-treasurer. The latter was elected for a two-year term.

ILLINOIS SECTION

New officers for the Illinois Section are as follows: L. D. Gayton, president; J. De N. Macomb and T. L. Condron, vice-presidents; G. B. Massey, secretary; and J. F. Seifried, treasurer. The officers elected by the Juniors of the Illinois Section are Hal P. Kibbey, president; Lawrence H. Lyle, vice-president; Albert M. Levy, secretary; and J. E. Goldberg, treasurer.

INDIANA SECTION

Field Secretary Jessup addressed a dinner meeting of the Indiana Section, which took place at the Hotel Washington in Indianapolis on December 2. Mr. Jessup spoke on the subject of "The Aims and Activities of the Society as Related to Those of the Sections," and an enthusiastic general discussion followed. There were 18 present. Vice-President Gowdy was guest of honor and speaker at a luncheon meeting of the Section that was held on December 13. A general discussion followed Mr. Gowdy's talk, which covered the Local Sections Conference at Rochester and the problems and issues raised there. Mr. Gowdy also described the function and operation of the Board of Direction. There were 14 present.

KANSAS CITY SECTION

The annual meeting of the Kansas City Section took place on December 15, with 37 members and guests present. A floor show entertained the members during dinner. The meeting was then called to order, and the principal speaker of the evening was introduced. This was Edward Shook, attorney of Kansas City, whose subject was "The Engineering Profession from the Legal Point of View." The recommendations of the nominating committee were also heard, and the following officers were unanimously elected: Ashley B. Taylor, president; R. N. Bergendoff, first vice-president; F. M. Cortelyou, second vice-president; and William M. Spann, secretary-treasurer. The meeting was then declared an open forum, and a number of those present commented briefly and interestingly on work in which they were engaged. The evening concluded with the presentation of certificates of life membership to W. O. Galbreath and G. C. Haydon.

KANSAS STATE SECTION

The presentation of certificates of life membership in the Society—to Lloyd B. Smith and Howard A. Fitch—was a feature of the December 9th meeting of the Kansas State Section. A technical program, consisting of a talk on the subject of "Safety and the Civil Engineer," followed. This was given by George A. Reid, safety engineer for the Kansas State Highway Commission. The meeting concluded with a report on the Local Sections Conference at Rochester, which was presented by F. W. Epps, secretary of the Section. There was an attendance of 34.

KENTUCKY SECTION

The Kentucky Section reports that several interesting meetings were held during the past year. On March 15 Art Boase, of the Portland Cement Association, addressed a gathering of 33 on the topic, "The Use of Concrete in Europe." At this session George H. Sager, Jr., also spoke, his subject being the new registration law for engineers in Kentucky. On May 14 members of the Section enjoyed a joint dinner meeting with the Student Chapters at the University of Kentucky and the University of Louisville. The attendance on this occasion was 35. A joint dinner meeting with Committee No. 8 of the Society for the Promotion of Engineering Education took place on September 5. J. S. Dodds, professor of civil engineering at Iowa State College, made the address of the evening. The guest speaker at the dinner meeting held on November 14 was Col. W. A. Danielson, constructing quartermaster at Fort Knox, Ky. Colonel Danielson spoke on the development of Fort Knox, using slides to illustrate his talk.

LEHIGH VALLEY SECTION

On December 12 the annual meeting of the Lehigh Valley Section took place with 37 present. The election of officers, which was held at this time, resulted as follows: George F. Roehrig, president; L. P. Grossart and E. F. Ball, vice-presidents; and M. O. Fuller, secretary-treasurer. The latter gave a report on the Local Sections Conference at Rochester, and a technical speaker was also enjoyed. This was Bruce Johnston, who discussed the subject, "The Structural Significance of Stress."

LOUISIANA SECTION

There were 24 members and guests present at a meeting of the Louisiana Section, which was held in New Orleans on December 16. The feature of the occasion was an interesting and instructive address on the subject of slum clearance and low-rent housing projects in New Orleans. This was given by Alvin M. Fromherz, consulting engineer and executive director of the Housing Authority of New Orleans. The object of this talk was to spread general information about federal and state acts dealing with housing projects and to acquaint members of the Section with the outstanding architectural features of the "efficiency houses" that will replace decrepit slum homes in New Orleans.

MARYLAND SECTION

Election of officers for the new year took place at a meeting of the Maryland Section, held at the Engineers Club in Baltimore on December 14. The results of the election were as follows: E. J. Dougherty, president; George E. Finck, vice-president; and Norman D. Kenney, secretary-treasurer. The latter was elected for a two-year term. A talk on Maryland's primary bridge program was also scheduled for this occasion. This was given by Herschel H. Allen, vice-president of the J. E. Greiner Company, of Baltimore.

METROPOLITAN SECTION

The Metropolitan Section held its third gathering of the season in the Engineering Societies Building on December 21. R. E. Bakenhus, president of the Section, opened the meeting with a tribute to the late Robert Ridgway, Past-President and Honorary Member of the Society. The subject of the meeting was "Park, Playground, and Parkway Developments in New York City and Long Island." This subject, which was illustrated by slides and motion pictures, was presented jointly by William H. Latham, consulting park engineer for the New York City Department of Parks, and Sidney M. Shapiro, assistant chief engineer for the Long Island Park Commission. The total attendance of 373

included about 100 students, the Section being host on this occasion to the eight Student Chapters in the metropolitan area. A social session and refreshments concluded the evening.

On December 14 the Junior Branch of the Section met at the Hotel Bristol in New York for its first dinner of the year. The guest speaker on this occasion was Eugene L. Macdonald, associate engineer for Parsons, Klapp, Brinckerhoff and Douglas, of New York City. Charles T. Murphy, who is to instruct the public speaking course for Juniors, was then presented to the group and spoke briefly. The attendance was 40.

MIAMI SECTION

A meeting of the Miami Section took place in the Seven Seas Restaurant on December 1, with 16 present. During the business session Milton B. Garris was elected president and Leroy S. Edwards, secretary-treasurer. Following the reading of a report on the recent activities of the Florida State Registration Board, the speaker of the evening, Anthony J. Daino, was introduced. Mr. Daino, who heads a construction company, discussed the technique of rock tunneling as practiced by his company on three New York City subway contracts. Mr. Daino made his comments especially interesting by unique blackboard sketches.

MID-MISSOURI SECTION

A business meeting, dinner, and smoker were sponsored by the Mid-Missouri Section on December 10. The officers of the Student Chapters at the University of Missouri and the Missouri School of Mines were guests of the Section on this occasion, and the total attendance numbered 45. Reports were read, and the Section went on record as favoring budgetary appropriations for topographical mapping in Missouri and other states. The annual election of officers then took place, with the following results: Harry Rubey, president; W. Scott Johnson, vice-president; Raymond W. Brooks, secretary-treasurer; and V. A. C. Gevecker, junior director. A delightful dinner and smoker followed the business session.

NASHVILLE SECTION

Eight members of the Nashville Section met for dinner and a technical session in Kissam Hall at Vanderbilt University on December 6. After the transaction of routine business those present heard a talk by Dr. Jewell, of Vanderbilt University, on the subject of earthquakes.

NEW MEXICO SECTION

On November 17 the New Mexico Section met in Albuquerque in joint session with the Student Chapter at the University of New Mexico and other engineering student groups on the campus. The speaker of the occasion was C. S. Howard, of the U. S. Geological Survey, who discussed the industrial and agricultural uses of water. A general discussion, led by Professor Ford, followed. There were about 50 present.

NORTHWESTERN SECTION

There was an attendance of 46 at the dinner meeting of the Northwestern Section held at the University of Minnesota on December 5. During the business session the following officers were elected for the coming year: H. S. Loeffler, president; A. F. Meyer, first vice-president; Arndt J. Duvall, second vice-president; and Frank Altman, secretary-treasurer. The technical program consisted of an interesting and enlightening talk on the water-conservation problems of the Red River of the North, given by E. V. Willard, chief engineer of the Minnesota State Department of Conservation.

OKLAHOMA SECTION

On December 16 the annual meeting of the Oklahoma Section took place, with 24 present. The feature of this occasion was an interesting illustrated lecture on "Petroleum Exploration and Experiences in South America," which was given by Dean W. H. Carson, of the University of Oklahoma. The annual election of officers resulted as follows: Frank Herrmann, president; A. H. Riney, first vice-president; D. H. Jones, second vice-president; and D. L. Wilson, secretary-treasurer.

OREGON SECTION

There were 40 present at a meeting of the Oregon Section that took place in Portland on December 7. After a brief discussion of business matters a technical program was enjoyed. This consisted of a talk by W. E. Milne, head of the mathematics department at Oregon State College. Refreshments were served at the close of the meeting.

PANAMA SECTION

At the annual meeting of the Panama Section, held at the Union Club in Panama City on December 5, the following new officers were elected: Emanuel Lyons, Jr., president; R. L. Klotz, first vice-president; W. D. Wright, second vice-president; and Clinton Morse, secretary-treasurer. The latter will serve a two-year term. After the business session an interesting film on the making of safety glass was shown by Lawrence Johnson, assistant superintendent of the Canal Zone Schools. This film was available through the courtesy of the U. S. Bureau of Mines. There were 23 present.

PHILADELPHIA SECTION

The November meeting of the Philadelphia Section, held jointly with the Chamber of Commerce, the Engineers Club, the Philadelphia Ordnance District of the Army, and the local branches of eight other societies, took place at the Bellevue-Stratford on the 9th. Following the dinner, Brig. Gen. C. T. Harris, Jr., assistant chief of the Ordnance Department of the U. S. Army, gave an address entitled "Plans for Industrial Mobilization." In his talk General Harris stressed the importance of cooperation between the Ordnance Department and industry in the event of a national emergency.

PITTSBURGH SECTION

President Riggs was guest of honor at the annual dinner of the Pittsburgh Section, held at the Duquesne Club on December 2. Following dinner, Dr. Riggs gave a brief résumé of the history of the Society and outlined the development of the present democratic form of administration that controls its activities. The attendance of 81 also included George T. Seabury, Secretary of the Society, who discussed the problems that must be met by the Juniors in establishing themselves in the profession. A joint meeting of the Pittsburgh Section and the civil engineering section of the Engineers Society of Western Pennsylvania took place at the William Penn Hotel on December 8. The speaker on this occasion was P. H. Bates, chief of the Clay and Silicate Products Division of the National Bureau of Standards, whose subject was "Trends in Cement Technology and Their Effect on Engineering Construction." There were 106 present.

The Junior Division of the Pittsburgh Section has held three meetings since its organization in the fall of 1938. The first of these, which took place in October, was for the purpose of organizing and discussing plans for the future. The meeting was opened by C. M. Reppert, president of the Pittsburgh Section, and later turned over to J. W. McKnight, newly appointed chairman of the Junior Division. Wilfred Bauknight was appointed secretary. At the second meeting, which was held on November 28, J. N. Chester gave a very interesting talk on the subject, "An Engineer's Visit to the North Cape." On December 15 John C. Kohl, of the Research Bureau of the Pittsburgh Plate Glass Company, presented an illustrated lecture on structural glass.

SACRAMENTO SECTION

During November and December the members of the Sacramento Section continued their custom of having weekly luncheon meetings. On November 1, there were 38 present to hear Thomas E. Stanton, Jr., Director of the Society, report on the Rochester and Salt Lake City meetings. On November 15, R. Robinson Rowe gave an interesting talk on prospecting for gold in southeastern Alaska, where he spent considerable time investigating power possibilities. There were 66 present at the meeting held on November 29. On this occasion W. H. Peterson, on the staff of the State Department of Public Works, described the new state office building now under construction in Sacramento. On November 22, there was a special evening meeting, at which a certificate of life membership was presented to Frederick M. Green. The lecturer on this occasion was Dr. J. E. Church, of the University of Nevada, who spoke on snow survey work. There was a business meeting on December 6, and on the 13th a program of impromptu talks was greatly enjoyed, the scheduled speaker having been unable to attend. Fred Sprague then showed two films—one on deep-sea fishing and one on winter sports. There

were 268 present on December 20 to enjoy the annual Christmas entertainment; and on December 27 Peter Franzen, professor of biology at the University of Nevada, gave a talk on "Some General Aspects of the Microbiology of Sewage."

San Francisco Section

At the regular meeting of the San Francisco Section, held on December 20, the results of a letter ballot for the election of officers were announced as follows: F. H. Fowler, president; J. I. Ballard, vice-president; and T. J. Corwin, Jr., secretary-treasurer. Then Guy F. Atkinson gave a talk on "The Construction of the Foundation of the Grand Coulee Dam." There were 138 at the meeting and 110 at the dinner preceding it. The new life members of the Society were guests of the Section at dinner and received their certificates of membership.

Seattle Section

The Seattle Section held its November dinner meeting at the Engineers Club on the 28th. Following dinner a film entitled "The Story of Douglas Fir" was shown to the group through the courtesy of the Pope and Talbot Company, of Portland, Ore. There were about 35 present.

Spokane Section

At the December meeting of the Spokane Section, which was held at the Davenport Hotel on the 9th, it was decided that three prizes of Junior membership in the Society will again be offered for the best papers submitted by senior civil engineering students in the three engineering schools within the Spokane Section area. It was also voted to award such a prize at this time to Joseph Collart, of Washington State College, for his paper on "Steel Bearing Piles," though the papers from this college were received after the contest closed and could not be judged with the others. A certificate of life membership in the Society was then presented to E. G. Taber, and the annual election of officers took place, with the following results: Phil G. Holgren, president; H. E. Phelps, first vice-president; A. J. Turner, second vice-president; and E. L. Haines, secretary-treasurer. A technical program consisting of the Society's lantern-slide lecture concluded the meeting.

Syracuse Section

Twenty members and guests of the Syracuse Section met for dinner in the Onondaga Hotel on January 9. The guests included Ernest F. Robinson, who was on a visit home from his work in Maracaibo, Venezuela, where he is in charge of preliminary work for deepening the harbor and extending the dock facilities. Colonel Robinson gave an interesting talk describing some of the difficulties encountered in carrying out his work. Following dinner and Colonel Robinson's talk, the Section was host to the Technology Club of Syracuse. Cecil S. Camp, assistant professor of civil engineering at Syracuse University, gave an illustrated lecture on the Tennessee Valley Authority before the combined attendance of 150.

Tacoma Section

Because of bad weather and hazardous driving conditions the attendance at the December meeting of the Tacoma Section was smaller than usual—25 members and 7 guests. However, those present enjoyed an interesting technical program consisting of three talks. These were given by C. E. Corser, bridge designer for the Washington State Highway Department; and J. G. Holmstrom and M. Aitken, respectively chief engineer and assistant engineer of the Kenworth Motor Truck Corporation. During the business meeting the following officers were unanimously elected for 1939: Ronald C. Knapp, president; Bertram P. Thomas, vice-president; and Wells H. Ashley, secretary-treasurer.

Tennessee Valley Section

On December 4 the Knoxville Sub-Section of the Tennessee Valley Section held a special meeting to clarify any questions on registration and the registration laws in Tennessee. The symposium was in charge of N. W. Dougherty, professor of civil engineering at the University of Tennessee and chairman of the Tennessee Board of Engineering and Architectural Examiners, who gave a detailed account of the law in Tennessee and the relationship between states that have such laws. There were about 40 present.

Toledo Section

An inspection trip through the Rossford (Ohio) plant of the Libby-Owens-Ford Glass Company was enjoyed by members of the Toledo Section on December 8 in place of a regular meeting. Sixteen members and guests made this trip, which included every process from batch mixing to grinding and polishing. The annual meeting of the Section took place on December 21, with 26 present. During the business session the following new officers were elected: H. M. Sharp, president; R. A. Nyquist, vice-president; and R. W. Abbott, secretary-treasurer. After a few words by the retiring president, P. W. McDonnell, the speaker of the evening was introduced. This was J. E. Root, Director of the Society, who discussed the origin and growth of the Society. At the conclusion of his talk two reels of the films entitled "Edgerton High Speed Movies" were shown through the courtesy of the Massachusetts Institute of Technology.

Utah Section

New officers for the Utah Section, elected on December 9, are as follows: Thomas C. Adams, president; George D. Clyde, first vice-president; L. M. Winsor, second vice-president; and F. H. Richardson, secretary-treasurer. Following the routine business session, Dr. Adams gave an interesting talk on the engineering developments along the Colorado River, which he illustrated with motion pictures taken during a recent trip along the river.

Wisconsin Section

There were 28 present at the annual meeting of the Wisconsin Section, which took place at the City Club in Milwaukee on December 14. The technical program consisted of a talk by William Monroe White, manager and chief engineer of the hydraulic department of the Allis-Chalmers Manufacturing Company. His subject, "Engineering Features of a Trip Around the World," proved extremely interesting. During the business session, which concluded the meeting, the following officers were elected for the coming year: J. P. Gebhard, president; C. A. R. Distelhorst, first vice-president; C. A. Willson, second vice-president; and Lloyd D. Knapp, secretary-treasurer.

Student Chapter Notes

Lehigh University

During the past semester the Lehigh University Student Chapter has had three meetings. The first of these was held in the Fritz Engineering Laboratory, where various interesting tests were conducted. At the second meeting there was a talk on flood control. This was given by Charles Ryder, chief engineer of the Department of Forests and Waters. At the third gathering R. A. Wahl, a representative of the Portland Cement Association, was the speaker. Mr. Wahl gave an illustrated lecture on "Modern Design of Concrete Highways."

University of Arkansas

The University of Arkansas Student Chapter recently was host to a banquet honoring L. L. Hidinger, Director of the Society, and H. N. Pharr, of the Mississippi River Commission. Following dinner Mr. Hidinger discussed the value of the Society to the Southwest. Mr. Pharr then gave an illustrated lecture showing steps in the development of the thirteen Mississippi River cut-offs. He also presented a technicolor film on the construction of the Sardis Dam on the Tallahatchie River, Mississippi.

University of Detroit

On November 22 the University of Detroit Student Chapter held a joint dinner meeting with the Michigan Section of the Society. A detailed account of this meeting appeared in the "News of Local Sections" department of the January issue of CIVIL ENGINEERING. Another meeting of the Chapter took place on December 13, with 33 present. The technical program on this occasion consisted of the presentation of an illustrated lecture on the construction of the Cascade Tunnel, and a talk on the garbage incinerator problem in Detroit. This was given by L. C. Wilcoxen, assistant engineer for the City of Detroit.

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for March

METHODS AND TOOLS used in subaqueous tunnel construction are the subject of an informative article by Howard L. King, which is scheduled for the March issue. The first half of the paper is a concise, thorough explanation of principles and methods in general; the remainder is given over to a discussion of recent subaqueous tunnels in Boston, New York, and Detroit, with special reference to new plant or special methods of construction involved in each.

Periodically CIVIL ENGINEERING has presented articles describing the manufacture of basic engineering materials. Thus in the past two years there have been papers covering lumber, asphalt, clay products, and aluminum. This series is resumed in the March issue, with the first of two articles by F. H. Frankland on the manufacture of iron and steel.

The field of water conservation is represented by two papers—one by Merrill Bernard, describing current mountain snowfall studies of the U. S. Weather Bureau, and another by A. T. Mitchelson explaining the "water spreading" methods used in California and elsewhere to replenish the underground storage by flood flows that would otherwise be wasted.

Space permitting, a contribution by Douglas S. Laidlaw of special interest to those engaged in the writing or revision of building codes will also be included. Mr. Laidlaw is not concerned with technical content so much as with arrangement and organization of material and editing of text—points that he believes are all too often neglected in code preparation.

From the Annual Meeting will come articles in the fields of sanitary engineering, highways, city planning, and shore protection, to round out the issue.

Forthcoming Meetings of Technical Organizations

MEETINGS that should attract many members of the Society have recently been announced by the American Concrete Institute, the Asphalt Institute, and the American Road Builders' Association.

The American Concrete Institute will meet in New York City on Wednesday, March 1, for its 35th annual convention. The program continues through Friday, March 3.

In Los Angeles, during the week of February 27, the Twelfth National Asphalt Conference will be held under the auspices of the Asphalt Institute. "Twenty years of progress in highway construction, with analysis of present materials, methods, and equipment" is the theme of the meeting.

In San Francisco, the American Road Builders' Association will hold its 36th annual convention and highway exhibit, March 7–10, concurrently with the national convention of the Associated General Contractors of America. Both papers and exhibits will have as their keynote "highways of tomorrow."

High Honor to Dugald C. Jackson

THE 1938 Edison Medal of the American Institute of Electrical Engineers—"the highest award in electrical engineering"—has been presented to Dugald C. Jackson, M. Am. Soc. C.E., "for outstanding and inspiring leadership in engineering education and in the fields of generation and distribution of electric power." The presentation was made on January 25, during the annual winter convention of the Institute in New York City.

Doctor Jackson received the degree of civil engineer from Pennsylvania State College in 1885, and spent the next two years in graduate study in electrical engineering at Cornell University. In 1891, he formed a consulting engineering firm with his brother, W. B. Jackson, and also became professor of electrical engineering at the University of Wisconsin. In 1907, he was appointed professor and head of the department of electrical engineering at the Massachusetts Institute of Technology, "in which position he notably wove research into the fabric of engineering education." The consulting engineering firm of Jackson and Moreland, organized in 1919, specialized in the fields of electric power production and distribution of railway electrification, with a nationwide and international list of clients. Doctor Jackson continued as senior partner until 1930, but retained his position at M.I.T. until 1935, when he retired as professor emeritus.

The Edison Medal, founded by associates and friends of Thomas A. Edison to perpetuate his memory and the memory of his great works, is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee of 24 of the leading members of the American Institute of Electrical Engineers.

Recent Pamphlets on Engineering Topics

A 110-page supplement to "Dams, a Bibliography" has just been issued by the Engineer School Library, Fort Belvoir, Va. The supplement lists books and articles published on the subject between April 1936 and September 1938. Like the original edition, it is in loose-leaf form. It is free to purchasers of the original bibliography, and lists at 50 cents to others.

The American Institute of Steel Construction has now published in pamphlet form its "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings." This specification was adopted in 1936 and editorially revised in 1937, but has not previously been available in the present compact form. It can be obtained from the Institute, 200 Madison Ave., New York, N.Y., at 10 cents a copy.

The Sixth Annual Report of the Engineers' Council for Professional Development can now be purchased from that organization, 29 West 39th Street, New York, N.Y., at 25 cents a copy. Of special interest in this publication is the report of the committee on engineering schools, which includes the revised list of accredited engineering curricula. Another important item is the summary of comparative study of the qualification procedure in the fields of accounting, architecture, law, and medicine.

"Planning Profitable Neighborhoods" is the title of a new 36-page bulletin of the Federal Housing Administration, which has been written as a guide to good neighborhood development and principally to assist the small developer. The principles of land subdivision that make neighborhoods more desirable are illustrated by "good" and "bad" examples, arranged in pairs. Eight examples of actual subdivision planning are also shown, each example including both the original plan submitted to the FHA and the suggested revised layouts made by its Land Planning Section. The bulletin is available through the Superintendent of Documents, Washington, D.C., at 20 cents a copy.

Page of Special Interest

The recent death of James Noble Hatch, M. Am. Soc. C.E., has called attention to the fact that he was well known for his poetry. A specimen appears on the Page of Special Interest of this issue, against a background of the Pickwick Landing Dam on the Tennessee River. Notice of Mr. Hatch's death, with a brief sketch of his career as an engineer, appears on page 68 of the January number of CIVIL ENGINEERING.

Projects and Publications of A.S.A.

THE Standards Council of the American Standards Association recently launched a new project of widespread interest to the building trades and to other groups concerned with more economical methods of building design and construction. Plans for the work include development of a basis for coordination of dimensions of building materials and equipment and

the correlation of building plans and details with such dimensions. This will mean standardization of the features of design of buildings as well as of materials entering into their construction. The Standards Council has authorized appointment of a technical committee representing all groups that have an interest in the project, with the further recommendation that this committee work under the joint leadership of the American Institute of Architects and the Producers' Council.

Also of interest to the building trades are the New American Standards Specifications for gypsum plastering and lathing, now available from A.S.A. headquarters, 29 West 39th Street, New York, N.Y. The specifications are comprehensive, and cover such topics as materials, mixes, finishes, thickness, and acoustical and other special-purpose plasters. The chapter on lathing covers a variety of lath types and includes specifications for constructing and erecting solid plaster partitions, metal wall furring, and so forth.

NEWS OF ENGINEERS

Personal Items About Society Members

RALPH BURKE has been granted a leave of absence as chief engineer of the Chicago Park District in order to serve in a similar capacity with the newly created city department of subway and traction. As such he will be field man in direct charge of construction of the new Chicago subway system.

H. G. GERDES, for the past three years on the engineering staff of the Federal Power Commission in Washington, D.C., is now with the Harza Engineering Company on the Santee-Cooper Project at Charleston, S.C.

FRED R. WHITE, chief engineer of the Iowa State Highway Commission, is the recipient of the George S. Bartlett Memorial Award of the American Association of State Highway Officials for outstanding service in the highway field. The presentation was made at the annual convention of the association, which was held in Dallas, Tex., December 5 to 8.

IRVING V. A. HUIE, who has been serving as acting commissioner of the New York City Department of Public Works, was recently appointed commissioner.

HOMER R. SEELY has been appointed deputy commissioner in charge of bridges for the New York City Department of Public Works. Mr. Seely was formerly resident engineer for the Triborough Bridge Authority.

GEORGE H. SAGER, JR., consulting engineer of Louisville, Ky., has been appointed executive director of the Louisville Municipal Housing Commission. Mr. Sager has resigned his recent post as engineer-secretary of the Louisville City Planning and Zoning Commission.

HOWARD F. PECKWORTH has completed his work as resident engineer in charge of the construction of Inland Dam for the Birmingham Industrial Water Supply Commission and is now on the engineering staff of Pacific Constructors, Inc., on the construction of Shasta Dam. He is located at Redding, Calif.

CHARLES ASH, assistant engineer for the Ohio State Highway Department, with headquarters at Lima, Ohio, has been appointed division engineer of Division No. 1 at the same location. Mr. Ash was formerly resident engineer inspector for the PWA at Springfield, Ohio.

HAROLD G. SOURS has been appointed assistant director of highways of Ohio. Mr. Sours was connected with the Ohio State Highway Department for a number of years and, more recently, served as consulting highway engineer for the Truscon Steel Company.

JAMES E. MALONEY has retired from his post as assistant engineer of the Colorado State Highway Department after a number of years of service. Mr. Maloney became connected with the first state highway organization in 1910, holding successively the posts of engineer and chief engineer. In 1921 the department was reorganized and enlarged, and Mr. Maloney was appointed assistant engineer.

FRANK W. BARNES, construction manager of the Merritt-Chapman and Scott Corporation, New York City, has been awarded the rank of Officer of the Crown by King Leopold III of Belgium, in recognition of his service in driving the Schelde River Tunnel at Antwerp, from 1930 to 1932. At that time Mr. Barnes was associated with Parsons, Klapp, Brinckerhoff and Douglas, consulting engineers for the Belgian government on the 5,800-ft vehicular tunnel. He directed construction operations on the project.

E. O. BERGMAN is now on the engineering staff of the C. F. Braun Company at Alhambra, Calif. For a number of years previously he was associate professor of civil engineering at the University of Colorado.

ELMER MUNGER recently resigned from the service of the St. Louis Southwestern Railway to accept probational appointment as junior engineer in the U. S. Engineer Office at Cincinnati, Ohio.

C. F. TELLER has accepted a position with A. McCormick, county engineer of Hardin County, Texas. His headquarters are at Kountze, Tex

VIRGIL BEAVERS has resigned as assistant traffic manager for the State-Wide (Texas) Highway Planning Survey in order to open a consulting office at Victoria, Tex.

CHARLES A. MAGUIRE has resigned his position as commissioner of public works at Providence, R.I., in order to open consulting offices in that city. He will also be active in engineering work on the North Providence sewerage project.

H. H. HOUK has resigned as chief engineer of the Alabama State Highway Department in order to become engineer and investigator for the Federal Civil Aeronautics Authority. Recently Mr. Houk has been on leave of absence from this post.

EARLE E. TEETER, until lately hydraulic engineer for the U. S. Engineer Office at Huntington, W.Va., has been appointed an engineer for the Federal Power Commission, with headquarters in Washington, D.C.

DECEASED

FRED EDWARD CALDWELL (M. '19) vice-president of the Haller Testing Laboratories, Inc., of New York City, died in Plainfield, N.J., on January 2, 1939, at the age of 59. Mr. Caldwell was consulting engineer for Clyde Potts from 1904 to 1918; field engineer for the Portland Cement Association from 1919 to 1922; vice-president of the Springfield Sand and Tile Company from 1924 to 1928; and engineer for the Keystone Portland Cement Company from 1928 to 1930. In 1932 he became connected with the Haller Testing Laboratories.

ALLAN WINTER CUDDEBACK (M. '10) president of the New York Water Service Corporation since 1931, died at his home in New York City on December 4, 1938, at the age of 70. Mr. Cuddeback entered the service of the Newark (N.J.) water-supply system in 1898 as an assistant engineer, retaining the post for twenty-eight years. From 1926 to 1933 he was vice-president and general manager of the Federal Water Service Corporation. In 1926 Mr. Cuddeback served as president of the American Water Works Association.

PHILIP HART (M. '27) president of the Pacific Bridge Company, of San Francisco, Calif., was drowned on November 29, 1938, when a Portland–San Francisco airplane made a forced landing in the Pacific. He was 51. In 1910 Mr. Hart began his engineering and contracting career on the West Coast. The firm of which he was president was responsible for many notable bridges, including the difficult construction of the south pier of the Golden Gate Bridge and the west-crossing spans of the San Francisco–Oakland Bay Bridge. At the time of his death Mr. Hart was returning from supervising the start of work on the Narrows Bridge at Tacoma, Wash.

EDWIN SETON JARRETT (M. '09) retired consulting engineer, who had been associated with the design and building of many important structures throughout the country, died in New York City on December 26, 1938. Early in his career Mr. Jarrett was connected with Sooysmith and Company. Later he organized and became vice-president of the Foundation Company, and from 1914 to 1928 he was president of the Jarrett-Chambers Company. From 1934 to 1937 Mr. Jarrett served as vice-president and acting head of Rensselaer Polytechnic Institute, pending the selection of a successor to the late Palmer C. Ricketts.

LANDRY LAFAYETTA KOEPER (M. '20) consulting engineer of Seattle, Wash., was killed in an automobile accident on November 29, 1938. He was 53. Mr. Koeper was engineer in charge of the Seattle office of the Pacific Engineering Company from 1909 to 1914; of Boyington, Church, and McCoy, Spokane, Wash., from 1914 to 1922; of the Oregon-Canadian Pulp and Paper Company from 1922 to 1926; and of the Oregon Lime Products Company in 1927 and 1928. In the latter year Mr Koeper returned to the Pacific Engineering Company, remaining until 1931, and from 1932 to 1935 he was engineer in charge of the Selkirk Power Company, Ltd., of Vancouver, B.C.

WASHINGTON IRVING LEX (M. '14) for many years in the employ of the American Bridge Company, died at his home in Philadelphia, Pa., on December 21, 1938, at the age of 64. Mr. Lex joined the staff of the American Bridge Company in 1900 —after three years with the Pencoyd Iron Works—and remained there for the rest of his life. Starting as squad foreman at the Pencoyd plant, he later served the company as assistant engineer in both New York and Philadelphia. As such he was in direct charge of making steel designs and estimates for many types of railroad and highway bridges.

WALLACE NELSON MAYHEW (M. '28) president and treasurer of the Montgomery Iron and Steel Company, Philadelphia, Pa., died on January 1, 1939, at the age of 58. Early in his career Mr. Mayhew was structural engineer for Stevens and Hannis and a partner in the Steward and Stevens Iron Works. Later he became a partner in the Montgomery Iron and Steel Company, of which he was finally sole owner. Mr. Mayhew patented several inventions.

RALPH MILLIS (M. '36) Major, Corps of Engineers, U. S. Army, died on November 11, 1938, at the age of 44. Major Millis spent his career in the service of the Corps of Engineers, his duties including direction of the Military Survey of Panama and four years in charge of the Engineer Reproduction Plant in Washington, D.C. From 1935 until his death he was district engineer of the Wilmington (N.C.) Engineer District. During the war Major Millis served with the 306th Engineers, 81st Division, in the United States, France, and Poland.

ASA HALL MORRILL (M. '10) chief engineer of the Boston and Maine Railroad, the Maine Central Railroad, and the Portland Terminal Company, died in Portland, Me., on December 20, 1938, at the age of 68. Mr. Morrill was with the New York, New Haven and Hartford Railroad in various engineering capacities from 1892 to 1913. In the latter year he became connected with the Boston and Maine, the Maine Central Railroad, and the Portland Terminal Company. He was made assistant chief engineer of these organizations in 1933 and chief engineer in 1936.

ARNALDO ALVES DA MOTTA (M. '35) contractor and consulting engineer of São Paulo, Brazil, was killed in an airplane accident on October 1, 1938. He was 42. A native of Brazil, Mr. da Motta spent his early career in highway construction and sanitary engineering work for the state of São Paulo. In 1923 he established his own practice in São Paulo, and from 1926 to 1930 also directed a branch of this firm (A. Motta and Barboza) in Rio de Janeiro.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

RICHARD AUSTIN MYERS (M. '26) of Charlotte, N.C., died there on December 28, 1938, at the age of 54. Early in his career Mr. Myers served as resident engineer for the Duke Power Company on the construction of the Great Falls and Rocky Creek dams. Later, as a junior engineer in the U. S. Engineer Office, he was engaged on the preliminary survey for one section of the inland waterway. He also supervised the construction of power lines for the South Carolina Light and Power Company (now part of the Duke Power Company system). Mr. Myers retired several years ago to supervise his realty holdings.

JOSEPH PETTUS NEWELL (M. '07) consulting engineer of Portland, Ore., died in that city on December 5, 1938, at the age of 72. From 1889 to 1907 Mr. Newell was in the employ of the Oregon Railway and Navigation Company (now part of the Union Pacific system), where he rose to the rank of division engineer in charge of maintenance of way on the Oregon division. In 1907 he established his consulting practice in Portland, where he specialized in railway matters. Mr. Newell served as a witness in all the major traffic rate investigations held in the Northwest for many years.

HENRY GORTON OPDYCKE (Assoc. M. '04) civil engineer of New York City, died on December 30, 1938, at the age of 68. During the building of the subways in New York, Major Opdycke directed the underpinning of the Pennsylvania Station and Grand Central Terminal. He had charge of the foundation work under the Metropolitan Opera House and served as a consultant on many New York City construction projects. During the war he was chief signal officer of the intermediate section of the A. E. F. in France, and was honored for exceptional service by both France and the United States.

ANGEL PEIMBERT (M. '06) civil engineer, Lineas Ferreas de Mexico, S.A. de C.V., Mexico D.F., died on August 26, 1938, at the age of 66. Mr. Peimbert was a native of Mexico City, where he did all his engineering work. From 1904 to 1929 he represented S. Pearson and Son, Ltd., of London, in that city—first as resident engineer and, afterwards, as consulting engineer. Later he was consulting engineer to the National Railways of Mexico and to the Mexican Presidency.

HARRY EDGAR SAWTELL (M. '14) structural engineer for Charles T. Main, Inc., of Boston, Mass., died on January 3, 1939. He was 65. Mr. Sawtell joined the staff of Charles T. Main in 1907, and since 1910 had been in charge of the steel and reinforced concrete design of many factory buildings and power houses in New England for this firm. Mr. Sawtell's earlier experience included two years with the Cumberland Manufacturing Company and five years with the Boston Steel and Iron Company.

WILLIAM SHEARER (Assoc. M. '21) surveyor in the U. S. Engineer Office at Sacramento, Calif., died on November 23, 1938, at the age of 52. Mr. Shearer's early experience was as substation operator in electrical construction, and for two years he was deputy county surveyor of Yuba County, California. During the war he served in the U. S. Navy as engineer officer on electrical and mechanical detail. Later he was for a number of years county surveyor of Sutter County and city engineer of Yuba City. In 1936 he entered the U. S. Engineer Office.

MILLER ARMSTRONG SMITH (M. '86) of Elizabeth, N.J., died there on January 3, 1939, at the age of 85. In the seventies Mr. Smith was assistant engineer in the Brooklyn (N.Y.) Department of City Works. He then went to the tropics where he spent much of the rest of his career in railway location and construction—in Mexico, Guatemala, and Cuba. From 1900 until his retirement in 1930 he maintained a general engineering practice in Havana, specializing in the construction of sugar factories and their railways.

WILLIAM SHACKELFORD SULLIVAN (M. '25) civil engineer of Washington, D.C., died at his home in that city on December 20, 1938, at the age of 53. Much of his early experience was in railroad work—with the Northern Pacific, the Pere Marquette, and other lines in the West. Later he was assistant engineer for the Philadelphia Department of City Transit. Eight years ago he went to Washington, where he was employed by the National Capital Park and Planning Commission.

GEORGE OLIVER TENNEY (Affiliate '01) since 1906 president of the Atlantic Bitulithic Company, Washington, D.C., died on November 6, 1938, at the age of 77. From 1886 to 1892 Mr. Tenney maintained a general engineering and contracting practice in Decatur, Ala.; from 1892 to 1895 he served as contractor on the construction of the Chickamauga National Park; and from 1895 to 1906 he had a general contracting practice in Spartanburg, S.C.

HARVEY ALFORD TUTEWILER (Assoc. M. '34) president of the Ready Mixed Concrete Corporation, of Indianapolis, Ind., was killed instantly in an automobile accident on December 8, 1938. He was 49. A lifelong resident of Indianapolis, Mr. Tutewiler was associated with the Standard Paving Company for over twenty-five years. Seven years ago he organized the Ready Mixed Concrete Corporation, of which he became president.

GEORGE PHILIP WINN (M. '22) consulting engineer of Jamaica, N.Y., died at his home there on December 29, 1938, at the age of 52. A native of Nashua, N.H., Mr. Winn had lived in Queens for eleven years. He established his own engineering firm in Jamaica in 1932, after serving two years as consultant to the Queens Chamber of Commerce. Earlier in his career he was for a number of years city engineer of Nashua.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1938, to January 9, 1939, Inclusive

ADDITIONS TO MEMBERSHIP

ALLISON, ALEXANDER, JR. (Jun. '38), 3406 Clay St., San Francisco, Calif.

ANDERSEN, MORRIS LLOYD (Jun. '38), 1130 North 24th St., Lincoln, Nebr.

ANDERSON, O'DEAN (Jun. '38), 57 North 4th East, Provo, Utah.

ANDREOPOULOS, THEODORE CHARLES (Jun. '38), 27 Benefit St., Worcester, Mass.

ANGELOS, PETER P. (Jun. '38), 81 Orchard St., New York, N.Y.

BAUGH, LAWRENCE MARION (Assoc. M. '38), Area Engr., Brazos River Conservation and Reclamation Dist., Kyle Hotel, Temple, Tex.

BELSHAW, DERWIN GEORGE (Jun. '38), Draftsman, Truscon Steel Co., Albert St. (Res., 1543 Florencedale Ave.), Youngstown, Ohio.

BENLINE, ARTHUR JAY (Assoc. M. '38), Res. Engr. Insp., PWA, 79 Lockwood Ave., Bronxville, N.Y.

BICKERSTAFF, RAYMOND MAYHEW (Jun. '38), 1209 Hopkins, Oakland, Calif.

BODMAN, JOSEPH DAY (Jun. '38), General Delivery, Fairbanks, Alaska.

BOEMANN, NEVIN WILLIAM (Jun. '38), 438 Ludlow Ave., Cincinnati, Ohio.

BONELL, JOHN ARTHUR, JR. (Jun. '38), 804 Ocean Ave., Huntington Beach, Calif.

BONIN, CHARLES CLEMENS (Jun. '38), 82 Caryl Ave., Yonkers, N.Y.

BOSTWICK, EMERSON HUGH (Jun. '38), 789 Norton Rd., Galloway, Ohio.

BOWMAN, GREYDON WEST (Jun. '38), 16626 Wark Ave., Detroit, Mich.

BROWN, WILLIAM JOSEPH (Jun. '38), 33 Myrtle Ave., Newark, N.J.

CARL, CHARLES ELARD (Jun. '38), 2042 Newcastle, Chicago, Ill.

CHRISTENSEN, NEPHI ALBERT (Assoc. M. '38), Dean of Eng., Colorado State Coll. of Agriculture and Mechanic Arts, Fort Collins, Colo.

CONANT, LEWIS FLEET (Jun. '38), Designer and Draftsman, S. B. Barnes (Res., 1716 Crest Drive), Los Angeles, Calif.

CONOVER, CLYDE STUART (Jun. '38), Route 1, Box 101, Albuquerque, N.Mex.

CORTELYOU, FRANK MORGAN, JR. (Jun. '38), 421 West 61st St., Kansas City, Mo.

CRAIG, KENNETH JOHN (Jun. '38), 1005 Pine St., Rolla, Mo.

CRAUMER, RICHARD LISLE (Jun. '38), Room 502, Y.M.C.A., Youngstown, Ohio.

CROSBY, SHELBY TAYLOR (Jun. '38), Box 63, Bastrop, Tex.

CYPHERS, ROBERT ELLSWORTH, JR. (Jun. '38), 19 Linwood Pl., East Orange, N.J.

DALTON, JOHN PATRICK (Assoc. M. '38), Insp. of Constr., Bureau of Yards and Docks, U. S. Navy, 86 Market St., Annapolis, Md.

DAVIDOFF, JAMES EUGENE (Jun. '38), 314 Fifth Ave., South, St. Cloud, Minn.

DEHART, ROBERT CHARLES (Jun. '38), Care, Armour Inst. of Technology, Civ. Eng. Dept., Chicago, Ill.

DOWD, MUNSON WHITE (Jun. '38), Junior Eng. Aide, Design Section, U. S. Engrs., Brooks Hotel, Yerington, Nev.

DOYLE, WILLIAM AUGUSTUS (Jun. '38), 2541 Fulton St., Berkeley, Calif.

EASON, STEARNS DAVID (Jun. '38), Rodman, State Highway Dept., Box 276, Brewster, Wash.

EBBE, EARL EDGAR (Jun. '38), Res. Engr., Black & Veatch, 4706 Broadway, Kansas City, Mo.

EGAN, JOHN ROBERT (Jun. '38), Project Engr., WPA, Albion, Nebr.

EMPEY, LEROY WILLIAM (Assoc. M. '38), Asst. Div. Engr., State Highway Comm. (Res., 920 North Maple Ave.), Green Bay, Wis.

EPSTEIN, RAYMOND (Jun. '38), 4950 South Chicago Beach Drive, Chicago, Ill.

FISHER, ALBERT STEVEN (Jun. '38), 757 North 5th St., Laramie, Wyo.

GALLAGHER, JOHN HUBERT, JR. (Jun. '38), 2536 North East 17th Ave., Portland, Ore.

GOLDMAN, MORTIMER LASKAR (Jun. '38), 113 North Ave., N.W., Atlanta, Ga.

GOODWIN, WILLIAM HENRY, JR. (Jun. '38), Pittsburg, N.H.

HARDING, ROBERT GEORGE (Assoc. M. '38), Cons. Engr., 606 Utah Savings & Trust Bldg., Salt Lake City, Utah.

HARVEY, ADDISON REESE, JR. (Assoc. M. '38), State Mgr., State-Wide Highway Planning Survey (Res., 100 Glenn Grattan Ave.), Montgomery, Ala.

HEDGES, JAMES ALLEN (Assoc. M. '38), With Div. of Eng., U. S. Forest Service, Box 354, Lakeview, Ore.

HILL, WILLIAM BEANS (Assoc. M. '38), Road Engr., U. S. Indian Service, 135 Imperial Boulevard, Reno, Nev.

HILPERT, JOHN MEIER (Jun. '38), 33 West Church, Bethlehem, Pa.

HOLTER, CHARLES ERSKINE (Jun. '38), Draftsman, Perring & Remington Co., 509 Cooper St., Camden (Res., 244 Glover St., Woodbury), N.J.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1939	
Members	5,640
Associate Members	6,257
Corporate Members	11,897
Honorary Members	27
Juniors	3,820
Affiliates	74
Fellows	1
Total	15,819

HUBERTY, MARTIN RICHARD (Assoc. M. '38), Associate Prof. and Chairman, Div. of Irrig. Investigations, Univ. of California, Room 146, P. B. Bldg., Univ. of California, Los Angeles, Calif.

HUCHTING, JOHN FREDERICK, JR. (Jun. '38), Engr., M. L. Stephenson Contr. Co., 6 Water St., Charleston, S.C.

JETT, DANIEL BOONE (M. '38), Prof. of Civ. Eng., New Mexico State Coll., State College, N.Mex.

JOHNSON, FREDERIC ARTHUR (Jun. '38), 17 Seventh St., N.W., Minot, N.Dak.

JOVE, JOSÉ ANTONIO (Jun. '38), San. Engr., Div. de Ingeniería Sanitaria, Ministerio de Sanidad, Este 4, No. 131, Caracas, Venezuela.

KEFFORD, BURGE BERNARD (Jun. '38), Care, Civ. Eng. Dept., Armour Inst. of Technology, Chicago, Ill.

KERBER, HENRY JOHN (Jun. '38), Timekeeper, Indiana Eng. & Constr. Co. (Res., 363 Douglas St.), Akron, Ohio.

KERR, ROBERT STANLEY (Jun. '38), 141 East Spruce Ave., Inglewood, Calif.

KLAUCK, FREDERICK ROBERT (Jun. '38), 602 Chilton Ave., Niagara Falls, N.Y.

KOELZER, VICTOR ALVIN (Jun. '38), Care, Hydraulics Laboratory, Univ. of Iowa, Iowa City, Iowa.

KOMLINE, THOMAS RAYMOND (Jun. '38), Asst. Engr., Joint Sewage Disposal Plant, Plainfield, N.J.

KREBILL, ROLAND FREDERICK (Jun. '38), Instrumentman, State Highway Comm., 200 North 6th St., Missouri Valley, Iowa.

KREJCHIK, GLENN CHARLES (Jun. '38), With State Highway Comm., La Crosse (Res., Friendship), Wis.

KREML, EDWARD KLEMENT (Jun. '38), Junior Civ. Engr., U. S. Engr. Office, War Dept. (Res., 2938 McElderry St.), Baltimore, Md.

LANGDALE, FREDERICK DARROW (Jun. '38), Care, Civ. Eng. Dept., Agri. and Mech. Coll. of Texas, College Station, Tex.

LANNING, ROBERT LAWRENCE (Jun. '38), 2220 Markham Way, Sacramento, Calif.

LEMKE, ARTHUR ATHNIEL (Jun. '38), Instr., Civ. Eng., Lewis Inst. (Res., 525½ Belden Ave.), Chicago, Ill.

LEWEY, ERNEST BANE (Assoc. M. '38), Hydrographer, U. S. Coast and Geodetic Survey, Washington, D.C.

LOWRY, RALPH (M. '38), Constr. Engr., U. S. Bureau of Reclamation, Redding, Calif.

LYDER, AUDLEY ARNOTT (Assoc. M. '38), Dist. Engr., Public Works Dept. (Res., 51 De Verteuil St.), Port of Spain, Trinidad.

MCCARTHY, JOHN TIMOTHY (Jun. '38), 131 Neptune Ave., New Rochelle, N.Y.

MCCLURE, JOHN PHILIP (Jun. '38), 780 East 11th Ave., Apartment 1, Denver, Colo.

MCLEROY, JOHN OTTO (Jun. '38), Care, Austin Bridge Co., Dallas, Tex.

MCWHORTER, WAYNE WHITTEN (Jun. '38), 126 North 2d East, Provo, Utah.

MANGANARO, CHARLES ANTHONY (Jun. '38), 140 West 4th St., New York, N.Y.

MARKS, FRANCIS JOSEPH (Jun. '38), 7235 South East Harold St., Portland, Ore.

MASON, CLINTON KENNETH (Assoc. M. '38), Supt.-Div. Const. Engr., State Highway Dept. (Res., 7 Park Ave.), Keene, N.H.

MERCHANT, WILFRED (Jun. '38), Graduate House, Mass. Inst. Tech., Cambridge, Mass.

METCALF, LAURENCE REGNELL (Jun. '38), Route 3, Hood River, Ore.

MIANO, SANTO (Jun. '38), Junior Draftsman, WPA Planning Div., 303 Washington St. (Res., 615 Pine St.), Brooklyn, N.Y.

MINASIAN, JOHN KACHIG (Jun. '38), 427 South Court St., Visalia, Calif.

MORRIS, ROBERT DEWAR (Jun. '38), 10416 North East Skidmore St., Portland, Ore.

MUGLER, RICHARD CARL WILLIAM (Assoc. M. '38), Secy.-Treas., Heydt-Mugler Co., Inc. (Res., 4611 Arlington Ave.), New York, N.Y.

NOVAK, LEO CHARLES (Jun. '38), Instr., Civ. Eng. Dept., Univ. of Colorado, Boulder, Colo.

NOYES, GEORGE ALLEN (Jun. '38), Nevada City, Calif.

OLSON, MARK WALDEMERE (Jun. '38), 5128 Blackstone, Chicago, Ill.

OSTERHOUDT, LAWRENCE JAN (Jun. '38), Orchard Heights, New Paltz, N.Y.

PAGE, MYRON ELLSWORTH, JR. (Jun. '38), 2d Lieut., Corps of Engrs., U.S.A., 1345 North Harrison St., Stockton, Calif.

PERRY, STARK BARNETT (Jun. '38), Box 195, Dothan, Ala.

PETERSON, CARL HILMER, JR. (Jun. '38), Instrumentman, State Highway Comm., Box 626, University, La.

POLSON, GROVER STERLING (Jun. '38), 1541 South Owasso, Tulsa, Okla.

ROTH, CHARLES OLIVER, JR. (Assoc. M. '38), Instr., Civ. Eng., Cooper Union, New York, N.Y. (Res., 199 Sanford Ave., North Plainfield, N.J.)

ROYER, BRUCE ANDERSON (Jun. '38), 527 East Benton St., Morris, Ill.

SAUNDERS, WILLIAM KENNON (Assoc. M. '38), Gen. Contr. (Couse & Saunders), 12740 Lyndon, Detroit, Mich.

SCALZI, JOHN BAPTIST (Jun. '38), 6 Maple St., Hopedale, Mass.

SCHRADER, GEORGE PHILIP, JR. (Jun. '38), 1512 Highland Ave., Bluefield, W.Va.

SEBBY, DAVID KAPLAN (Jun. '38), With U. S. Geological Survey, 338 Security Mutual Bldg. (Res., 95 Front St.), Binghamton, N.Y.

SHANNON, GERALD TILDEN (Jun. '38), Rodman, Holway & Neuffer, Vinita, Okla.

SHELHORSE, WILLIAM HENRY (Jun. '38), 398 Monument Ave., Atlanta, Ga.

SHERMAN, CLYDE KEENER (Jun. '38), 634 Sixth Ave., North, Glasgow, Mont.

SIEWERT, HENRY GUST (Jun. '38), 2115 H St., Sacramento, Calif.

SIKKIND, ALFRED (Jun. '38), Field Engr., Parker Wrecking Co., New York (Res., 1056 Neilson Ave., Far Rockaway), N.Y.

SMIDL, JAMES GEORGE (Jun. '38), Draftsman and Traffic Analyst, State Highway Dept. (Res., 4210 West 21st Pl.), Chicago, Ill.

SMITH, GEORGE WIER (Jun. '38), 420 Clinton Ave., Brooklyn, N.Y.

SMOUSE, KENNETH JAMES (Jun. '38), 253 North Broadway, Portland, Ore.

SNYDER, WILLIAM OSCAR (Assoc. M. '38), Field Engr., Portland Cement Assoc., 125 East Campbell St., Frankfort, Ky.

SPEEG, KERMIT VINCENT (Jun. '38), U. S. Engr. Office, Galveston, Tex.

SPIEGEL, ROBERT JACOB (Jun. '38), Junior Engr. (Grade B), State Highway Comm., Oberlin, Kans.

SPIRES, HAROLD EMERSON (Jun. '38), 927 Title and Trust Bldg., Phoenix, Ariz.

STECKER, WILLIAM WALLACE (Jun. '38), U. S. Engr. Office, 418 Patterson Bldg., Fresno, Calif.

STOCKMAN, CHARLES EDWARD (Jun. '38), 2357 Baker St., Baker, Ore.

SUMMERSETT, JOHN, JR. (Jun. '38), Box 1041, Mason City, Wash.

THOMAS, ERVIN LINWOOD (Jun. '38), Woodland Ave. and Mill Rd., Pleasantville, N.J.

THOMPSON, HENRY LOREN (Jun. '38), Instr., Civ. Eng., Univ. of Idaho, Moscow, Idaho.

THORNBER, CHALMERS HARVEY (Jun. '38), Student Asst., SCS, R.F.D. 2, Hamilton, Mont.

WAGNER, FRANCIS VINCENT (Jun. '38), 147 East 81st St., New York, N.Y.

WAGNER, VICTOR KAREL, JR. (Jun. '38), With U. S. Waterways Experiment Station (Res, 1333½ Chamber St.), Vicksburg, Miss.

WALLACE, MILTON IRVING (Jun. '38), 2d Lieut., Corps of Engrs., 11th Engrs., Corozal, Canal Zone.

WESTKAMPER, BERNARD PAUL (Jun. '38), Axeman, U. S. Engrs., Post Office Bldg., Sacramento, Calif.

WHEELER, HARRY PAUL (Jun. '38), 104 Seventh Ave., S.E., Aberdeen, S.Dak.

WIKSTROM, VERNER ANTON (Jun. '38), 2327 Eleventh Ave., North, Seattle, Wash.

WRIGHT, NEWTON BATEMAN (Jun. '38), 1612 Ivanhoe St., Denver, Colo.

ZALOUDEK, JAMES (Assoc. M. '38), Draftsman, Burrell Eng. & Const. Co., 5655 Drexel Ave., Chicago, Ill.

MEMBERSHIP TRANSFERS

ANDERSON, IRVING ELMER (Jun. '31; Assoc. M. '38), Asst. Engr., U. S. Geological Survey, Water Resources Branch, 406 Federal Bldg., Tacoma, Wash.

AROSEMENA, LEOPOLDO (Assoc. M. '26; M. '38), Secy. of Public Works and Public Health, Republic of Panama, Apartado 33, Panama, Panama.

BROWN, JOHN MAUGHS (Assoc. M. '13; M. '38), Dist. Highway Engr., U. S. Indian Service (Res., 1311 West 24th St.), Minneapolis, Minn.

CONTRERAS, MARIANO JESUS (Jun. '28; Assoc. M. '38), Civ. Engr., Servicio Portuario, Obras y Servicio del Puerto, La Guaira, Venezuela.

CULLUM, ROBERT SEVERNE (Jun. '37; Assoc. M. '38), Area Engr., Area 40, WPA (Res., 207 West Cedar St.), Coleman, Tex.

DALEN, JOHN ALBERT (Assoc. M. '19; M. '38), Cons. Structural Engr., 125 East 46th St., New York, N.Y.

DILLARD, JOHN LEA (Assoc. M. '04; M. '38), Pres. and Gen. Mgr., The Sturm & Dillard Co., 417 Huntington Bank Bldg., Columbus, Ohio.

HOFFMAN, IRVING CHARLES (Jun. '33; Assoc. M. '38), Engr., Griffith Co., 1060 South Broadway, Los Angeles, Calif.

HORTON, DONALD FRANCIS (Jun. '27; Assoc. M. '38), Associate Engr., U. S. Engr. Office, 3d Floor, Park Sq. Bldg., Boston, Mass.

JOHNSON, TOM ROYSE (Jun. '31; Assoc. M. '38), Associate Engr., U. S. Bureau of Reclamation, Bartlett Dam, Cavecreek, Ariz.

KENNEDY, KLEIN WEBB (Jun. '27; Assoc. M. '38), Associate Engr., U. S. Forest Service, Ogden, Utah.

KLUGE, RALPH WENDEL (Jun. '28; Assoc. M. '38), Special Research Associate, Theoretical and Applied Mechanics, Univ. of Illinois, 104 Talbot Laboratory, Univ. of Illinois, Urbana, Ill.

MCFARLAND, CLIFTON BENEDICT (Jun. '26; Assoc. M. '38), Designing Engr., WPA, U. S. Navy Yard (Res., 23 King St.), Charleston, S.C.

MILLER, ROGER LIGHT (Jun. '28; Assoc. M. '38), Asst. Project Engr., Sun Oil Co., 1608 Walnut St., Philadelphia (Res., 314 Boyer Rd., Cheltenham), Pa.

PHILLBO, ROLLAND ALSON (Jun. '30; Assoc. M. '38), Structural Designer, Dlouhy & Evans, Los Angeles, Calif.

REINSTATEMENTS

DODGE, RUSSELL ALGER, Assoc. M., reinstated Jan. 3, 1939.

ELLER, EDWIN CAMERON, Assoc. M., reinstated Jan. 9, 1939.

GARDNER, THOMAS HERBERT, Assoc. M., reinstated Jan. 3, 1939.

GILMAN, GEORGE THOMAS, Assoc. M., reinstated Jan. 3, 1939.

GLENN, HOWARD EMMIT, Assoc. M., reinstated Jan. 3, 1939.

LANIGAN, JOHN JOSEPH, Jun., reinstated Jan. 3, 1939.

MCDONNELL, RICHARD TIMOTHY, Assoc. M., reinstated Jan. 3, 1939.

NAGIN, HARRY, Assoc. M., reinstated Jan. 3, 1939.

SCHANTZ, MAXWELL, Assoc. M., reinstated Jan. 3, 1939.

SHRIVER, KARL HENRY, M., reinstated Jan. 3, 1939.

SMEED, HAROLD FRANKLIN, Assoc. M., reinstated Jan. 3, 1939.

RESIGNATIONS

AKERS, ELTON DOUGLAS, Assoc. M., resigned Dec. 29, 1938.

ALDRICH, EUGENE VOLNEY, Jun., resigned Dec. 31, 1938.

ANDREWS, ERIC ALEXIS, M., resigned Jan. 6, 1939.

ARNOLD, RICHARD ROBERTS, Jun., resigned Jan. 5, 1939.

BEAN, SHERMAN HUNN, Jun., resigned Dec. 16, 1938.

BELMONT, FRANKLYN EDWARD, M., resigned Dec. 29, 1938.

BRIGGS, ANDREW GORDON, M., resigned Dec. 31, 1938.

BRODKIN, NATHAN DANIEL, Assoc. M., resigned Jan. 5, 1939.

BUERGER, CHARLES BERNARD, M., resigned Dec. 27, 1938.

CAMPBELL, WILLIAM ALDEN, Jun., resigned Dec. 14, 1938.

CARLSON, CONRAD VICTOR, Jun., resigned Dec. 13, 1938.

COLLAR, WILLIAM FRANKLIN, Assoc. M., resigned Dec. 29, 1938.

CUMMINS, CHARLES ALBERT, Assoc. M., resigned Dec. 12, 1938.

DAMIANO, VINCENT FERDINAND JOSEPH, Jun., resigned Jan. 5, 1939.

DRAKE, RALPH EDMUND, Assoc. M., resigned Dec. 28, 1938.

DUFFY, WILLIAM BERNARD, Assoc. M., resigned Jan. 5, 1939.

ELLIS, JOHN RUSSELL, Assoc. M., resigned Jan. 5, 1939.

ERICKSON, JACOB, Jun., resigned Dec. 27, 1938.

FAY, ALBERT JAMES, Assoc. M., resigned Dec. 29, 1938.

FOSTER, WILLIAM SOUTHMAYD, Jun., resigned Dec. 16, 1938.

FOX, HAROLD KINNE, M., resigned Jan. 6, 1939.

GEORGE, GARDNER CLIFFORD, M., resigned Dec. 27, 1938.

GRIFFITH, JAMES RINALDO, M., resigned Dec. 27, 1938.

HALLSTROM, IRVING THORELL, Assoc. M., resigned Dec. 27, 1938.

HARBAUGH, ROSS ANDERSON, Assoc. M., resigned Dec. 31, 1938.

HARRIS, GEORGE WENTZ, M., resigned Dec. 29, 1938.

HART, JOSEPH HALL, JR., Jun., resigned Dec. 9, 1938.

HAVER, ELMER CONNET, Jun., resigned Dec. 16, 1938.

HAY, STANLEY GARDINER, Assoc. M., resigned Dec. 31, 1938.

HIGH, EDWARD LOUIS, Jun., resigned Dec. 31, 1938.

HOROWITZ, HYMAN, Jun., resigned Jan. 6, 1939.

JAHN, JOHN ROYAL, Assoc. M., resigned Jan. 6, 1939.

JONES, EDWARD LINDLEY, Assoc. M., resigned Dec. 21, 1938.

JONES, LEE MORGAN, M., resigned Dec. 27, 1938.

KUNTZ, GUY THEODORE, M., resigned Jan. 5, 1939.

LANCEFIELD, ROBERT LYNN, Jun., resigned Dec. 29, 1938.

LONEY, NEIL MCINTYRE, M., resigned Dec. 20, 1938.

LUIPPOLD, JEROME WILLIAM, Jun., resigned Dec. 31, 1938.

LUKESH, GUSTAVE RUDOLF, M., resigned Dec. 28, 1938.

MABIE, HENRY CLAY, Jun., resigned Dec. 9, 1938.

MENEGHELLI, HUGO ANTONIO, Jun., resigned Dec. 13, 1938.

NOBES, CHARLES WILLIAM, Jun., resigned Dec. 9, 1938.

PATTERSON, EVERETT GATES, Jun., resigned Dec. 21, 1938.

RANDIG, WESLEY HERBERT, Assoc. M., resigned Jan. 5, 1939.

RICE, ERNEST GRAHAM, Assoc. M., resigned Dec. 31, 1938.

RUPP, GEORGE WELLINGTON, M., resigned Dec. 27, 1938.

STROUT, GALE STANLEY, Assoc. M., resigned Dec. 20, 1938.

THAYER, WELLMAN PERRY, Jun., resigned Dec. 27, 1938.

THOMPSON, HARRY LAWRENCE, Assoc. M., resigned Dec. 12, 1938.

TUCKER, FRANK BERNARD, Assoc. M., resigned Dec. 21, 1938.

VOLDRICH, CONSTANTINE BRZOBOHATY, Jun., resigned Dec. 9, 1938.

WAUGH, JOSEPH EDWARD, Jun., resigned Dec. 31, 1938.

WEYHER, THEODORE ADDISON, Assoc. M., resigned Dec. 9, 1938.

WINSHIP, LEF, Assoc. M., resigned Jan. 5, 1939.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

February 1, 1939 NUMBER 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

GRADE	GENERAL REQUIREMENT	AGE	LENGTH OF ACTIVE PRACTICE	RESPONSIBLE CHARGE OF WORK
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

FOR MEMBER

CRAWFORD, EDWARD MILES, San Jose, Costa Rica, C.A. (Age 38) (Claims RCA 7.0, RCM 9.4) June 1932 to date Chf. Engr., Santa Marta R.R. Co., and Magdalena Fruit Co.; previously Asst. Chf., Imperial Rys. of Persia.

DODGE, RUSSELL ALGER (Assoc. M.), Ann Arbor, Mich. (Age 45) (Claims RCA 4.0 RCM 13.0) Sept. 1921 to date with Univ. of Michigan as Instructor in, Asst. Prof., and (at present) Associate Prof. of, Eng. Mechanics; since Sept. 1921 also on practical engineering, and since 1933 Consultant to City of Bay City, Mich., on sewer design and construction.

EMERY, PAUL, Kansas City, Mo. (Age 48) (Claims RCA 11.0 RCM 9.3) Sept. 1929 to date with Kansas City (Mo.) Bridge Co. as Office Engr. in charge of drafting room on design for erection of large steel bridges, etc., and since Dec. 1938 Asst. Chf. Engr.

GARDNER, THOMAS HERBERT, St. Augustine, Fla. (Age 47) (Claims RCA 5.8 RCM 9.5) May 1929 to date Structural Engr., Florida East Coast Ry., in responsible charge of design, fabrication, and erection of structures, etc.

KEATING, CHARLES STANLEY, Syracuse, N.Y. (Age 58) (Claims RC 31.2 D 21.6) March 1921 to date with City of Syracuse, as Asst. Engr., Senior Asst. Engr., Deputy City Engr., and (past 10 years) Cons. Engr. to City Engr.'s Office.

LOEHR, JOHN JACOB, Louisville, Ky. (Age 53) (Claims RCA 3.2 RCM 15.2) Nov. 1922 to June 1923 and Jan. 1925 to date with Commrs. of Sewerage, as Draftsman, Jun. Engr., and (at present) Designing Engr.; in the interim successively Computer, Miami Conservancy Dist., and Asst. Engr., Div. of Water City of Dayton, Ohio.

MCDONALD, NORMAN GEDDES, Toronto, Ont., Canada. (Age 45) (Claims RC 14.9 D 11.0) April 1922 to date with Gore, Nasmith & Storrie (now Gore & Storrie), Cons. Engrs., as Asst. Engr., and since May 1934 member of firm.

MEEHAN, JOSEPH ALOYSIUS, New York City. (Age 55) (Claims RCM 19.0) Feb. 1907 to date with Dock Dept., as Topographical Draftsman, since 1920 Asst. Engr., Grade 4, and at present also Acting Chf. Engr. of Dept.

O'REILLY, ANTHONY RAUEN (Assoc. M.), Reading, Pa. (Age 41) (Claims RCA 5.7 RCM 14.3) Sept. 1937 to date Cons. Engr. and Constructor on general contracts, chiefly PWA projects; previously Engr. Special Agt., Div. of Investigations, PWA, New York City; with Bureau of Water, Reading, Pa., as Civ. Engr., Gen. Mgr., and Chf. Engr.

PETTIBONE, GILBERT WILLIAM, Paso Robles, Calif. (Age 39). (Claims RC 5.9 D 2.0) April 1938 to date in full charge of State Aid flood-damage repairs, bridges, culverts, roads and levees in San Luis Obispo, Monterey, and Santa Cruz Counties, Calif.; previously Asst Res. Engr. with A. N. Lund, Stockton, Cali Aug. 1934 to April 1936 on various engineering work.

RAPPLEYE HOWARD SNYDER, (Assoc. M)., Washington, D.C. (Age 46) (Claims RC 12.4) Jan 1917 to date (except about 1 year with U. S. Army) with U. S. Coast & Geodetic Survey, as Field Draftsman, Hydrographic Draftsman, Computer, Mathematician, etc., and since Aug. 1929 Chf. of Sec. of Leveling.

THIEME, FRED ERNEST (Assoc. M.), Missoula, Mont. (Age 49) (Claims RC 30.7 D 8.0) June 1912 to date with U. S. Forest Service as Surveyor, Asst. Engr, Asst. Dist. Engr., Dist. Engr., Regional Engr., and since Sept. 1935 Asst. Regional Forester, in charge of Div. of Eng.; since May 1938 also Superv. Engr., Missoula County Airport.

WALLACE, JOHN ALBERT, Albany, N.Y. (Age 50) (Claims RCA 15.6 RCM 10.5) Dec. 1925 to date with New York State Div. of Eng., until April 1930 as Asst. Engr. (Structural Steel & Reinforced Concrete Designer), successively with Bureau of Bridges and Bureau of Grade Crossings, and (since April 1930) Senior Grade Engr., on grade-crossing elimination projects.

ZIMMERMANN, EMIL CARL, New York City. (Age 49) (Claims RCA 5.0 RCM 18.0) 1920–1938 Engr., Sales Engr., standards in design, railroad devices, inspection at foundries and rolling mills, Valuation Engr.

FOR ASSOCIATE MEMBER

ALTHOUSE, RAYMOND RICHARD (Junior), Union, N.J. (Age 32) (Claims RC 1.2 D 0.8) Jan. 1939 to date with Sanborn and Bogart on concrete designing and detailing; previously with Thomas F. Bowe on similar work; Hydr. Designer, Phoenix Eng. Corporation; Jun. Engr., Port of New York Authority.

ARGETSINGER, JOHN DEEM (Junior), New Ulm, Minn. (Age 32.) (Claims RC 4.4 D 0.8) July 1934 to date with Minnesota ERA and WPA, successively as County Engr., Pipestone County, Area Engr., Pipestone, Rock, Murray, and Nobles Counties, and (at present) Asst. Dist. Engr. for 33 counties, inspecting and planning construction, etc.

ARMSTRONG, HENRY K, Fort Peck, Mont. (Age 31) (Claims RC 4.7 D 1.0) Oct. 1933 to date with U. S. Engr. Office, as Office Engr., Asst. Civ. Engr., and (at present) Associate Civ. Engr.

BARBER, ARMOUR GAYLORD, Detroit, Mich. (Age 31) (Claims RC 4.0) June 1937 to date Engr. for A. Rossi, Gen. Sewer Contr.; previously Senior Civ. Draftsman, Dept. of Public Works; with Michigan State Highway Dept. as Draftsman, Instrumentman, Inspector, Road Project Engr., and Survey Chf.

BEATTY, JOHN MATTHEW (Junior), Troy, N.Y. (Age 32) (Claims RC 1.4) Sept. 1929 to date Instructor in Civ. Eng., Rennsselaer Polytechnic Institute; summers 1931–1935 and part of time summer 1938 Asst. Engr. with Solomon & Keis, Cons. Engrs., Troy, N.Y.

CLEARY, EDWARD JOHN, Upper Montclair, N.J. (Age 32) (Claims RCA 2.5 RCM 0.0) June 1935 to date Asst. Editor, *Engineering News-Record*, also Lecturer, Public Works Organization and Administration, New York Univ., Mgr., (Yonkers, N.Y. Branch) William J. Howe Coal Co.; Research Asst., Dept. of Sewage Disposal, New Jersey Agricultural Experiment Station.

COMM, EDWARD DANIEL (Junior), Bismarck, N.Dak. (Age 27) (Claims RCA 2.0 RCM 2.0) Aug. 1935 to date with WPA as Asst. Dist. Engr., and since Feb. 1936 Dist. Engr.; previously Asst. Dist. Engr., FERA; Rodman, U. S. Geological Survey; Ballistician, Federal Cartridge Corporation.

DOBBINS, EARL GEORGE (Junior), Chattanooga, Tenn. (Age 32) (Claims RCA 3.9 RCM 6.0) Aug. 1933 to date with TVA, as Chf. of Party, Engr. Office Asst., Chf. and Prin. Eng. Aide, and (at present) Asst. Civ. Engr.; previously Chf. of Party, U. S. Engr. Office.

DOWNWARD, PAUL HOLLINGSWORTH, Philadelphia, Pa. (Age 34) (Claims RCA 2.0 RCM 1.3) 1934 to date on various minor engineering